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An Evaluation of the Impact of the Adoption of the Onboard Module Building Cotton Harvest System on the Economic Competitiveness of Cotton Production in Louisiana

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AN EVALUATION OF THE IMPACT OF THE ADOPTION OF THE ONBOARD MODULE
BUILDING COTTON HARVEST SYSTEM ON THE ECONOMIC COMPETITIVENESS OF
COTTON PRODUCTION IN LOUISIANA

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ABSTRACT

Planted acreage of cotton in Louisiana has decreased over the past several years due to higher cotton variable production costs, stagnant cotton market prices, and higher grain yields and market prices for corn and soybeans. The general objective was to determine the economic impact of the adoption and use of an onboard module building cotton harvest system on the ability of the cotton enterprise to compete for planted acreage in the mixed crop farming areas of Louisiana. Specific research objectives included the estimated of comparative ownership and operating costs for the module building harvest systems relative to existing basket/module builder harvest systems, and to evaluate the impact of the use of the new cotton harvest system on expected levels of crop rotation net returns. SERF analysis was utilized to evaluate the impact of risk preferences on the crop rotation decision.

The total cotton system harvest cost for a 6-row module picker was estimated to be $51 per harvested acre, compared to $77 per acre for a 6-row basket harvest system and $149 per acre for a 4-row basket harvest system. Two levels of mean crop yields were evaluated: average yield history in the region (cotton – 1,150 lbs./acre, corn – 154 bu./acre, soybeans – 44 bu./acre), and recently observed higher yields for cotton and corn (cotton – 1,380 lbs./acre, corn – 176 bu./acre). Results indicated that cotton/corn rotations generally had higher expected net returns above variable costs over cotton/soybean and corn/soybean rotations under the price, yield and cost assumptions of the study.

Risk efficiency evaluation of crop rotation alternatives indicated that the cotton/corn rotations were generally more dominate than the cotton/soybean rotations, due primarily to the higher level of expected net returns from corn production compared to expected net returns from soybean production. The risk analysis along with the net return simulation analysis conducted

confirmed the continuing importance of the levels of expected crop market prices and yields in determining optimal crop rotation choices.

CHAPTER 1. INTRODUCTION

1.1 General Introduction

Cotton has historically been a major row crop produced in Louisiana. In Louisiana, cotton has been traditionally grown in rotation with other row crops. Although cotton acreage has varied from year to year in response to the expected price of cotton as well as the expected price of competing crops, sizeable acreages of cotton were planted each year in the state. Over the thirty-seven year period from 1970 through 2006, harvested acreage of cotton in Louisiana exceeded 500,000 acres every year except six and exceeded 400,000 acres every year except one (NASS, USDA). From 1989 to 2005, cotton harvested acreage in the state exceeded 600,000 acres every year. In 1995, Louisiana cotton producers harvested 641.61 million pounds of cotton lint from 1.06 million acres of cotton (LSU AgCenter, 1995). The total value of the 1995 Louisiana cotton crop (lint and seed) was valued at $594.1 million, the highest for any row crop produced in the state during that year.

Over the past several years, however, cotton acreage in Louisiana has declined substantially. In 2006, Louisiana had 630,000 harvested acres of cotton (NASS, USDA). By 2012, harvested acreage had declined to 225,000 acres. The reduction in cotton acres in the state has been due primarily to declining net returns from cotton production, due to rising cotton variable production costs and stagnant market prices. In 1994, the total variable production costs of producing dryland cotton in the Mississippi River Delta area of Louisiana were estimated to be $386 per acre (Paxton). In 2012, this variable production cost was estimated at $544 per acre

Table 1.1 – Louisiana Harvested Acreage of Cotton, Corn and Soybeans, 1980-2012

	Harvested acreage		
Year	Cotton	Corn	Soybeans
1980	560,000	30,000	3,350,000
1981	695,000	33,000	3,030,000
1982	595,000	40,000	2,900,000
1983	410,000	56,000	2,620,000
1984	645,000	82,000	2,430,000
1985	630,000	205,000	2,100,000
1986	570,000	385,000	1,750,000
1987	600,000	211,000	1,650,000
1988	645,000	125,000	1,950,000
1989	620,000	142,000	1,750,000
1990	790,000	186,000	1,750,000
1991	820,000	247,000	1,060,000
1992	870,000	309,000	1,170,000
1993	875,000	210,000	1,300,000
1994	890,000	306,000	1,120,000
1995	1,075,000	221,000	1,040,000
1996	885,000	523,000	1,080,000
1997	650,000	417,000	1,350,000
1998	525,000	540,000	1,070,000
1999	610,000	330,000	990,000
2000	695,000	370,000	850,000
2001	855,000	307,000	610,000
2002	495,000	540,000	660,000
2003	510,000	500,000	740,000
2004	490,000	410,000	990,000
2005	600,000	330,000	850,000
2006	630,000	290,000	840,000
2007	330,000	730,000	600,000
2008	234,000	510,000	950,000
2009	225,000	610,000	940,000
2010	249,000	500,000	1,020,000
2011	290,000	570,000	980,000
2012	225,000	530,000	1,115,000

Source: National Agricultural Statistics Service, USDA.

(Deliberto and Salassi). With relatively stable cotton yields, stagnant cotton market prices have substantially reduced the ability of cotton to compete for planted acreage in the mixed-crop areas of the state. Although soybean acreage in Louisiana has remained relatively stable at roughly one million acres over the past several years, much of the acreage previously devoted to cotton has been replaced with plantings of corn. The significant increase in corn market prices recently has significantly improved the net returns from corn production in the state. In 2006, Louisiana had 290,000 acres of corn harvested (NASS,USDA). In 2007, corn acreage increased to 730,000 acres and since that time has not dropped below 500,000 acres.

Every so often, a change in production technology comes along which can also serve to significantly lower per unit production costs. The recent development of onboard module building cotton harvesters does provide an opportunity for cotton producers to lower harvest costs per acre and thereby contribute to lower total production costs per pound of cotton. Traditional cotton harvest units, whether a picker or stripper, deposit harvested cotton lint in an onboard basket which is later unloaded into a module builder. Capacities of these onboard baskets vary greatly depending upon the specific size and type of harvester. Stripper machines have basket capacities in the 800 to 900 cubic feet range. Traditional cotton pickers will have basket capacities of approximately 1,150 cubic feet for 4-row pickers and 1,400 cubic feet for 6-row pickers. Capacities of these onboard baskets will hold about 7.5 pounds of cotton per cubic foot. The Model 7660 is the current version of a 6-row basket cotton picker manufactured by John Deere.

Two major agricultural equipment manufacturers have offered onboard module building cotton pickers to cotton producers over the past few years. Case-IH manufactures the Module Express 625 picker, a 365 horsepower machine which forms harvested cotton into a module. This is a 6-row cotton picker with a 4,000 to 12,000 pound module chamber capacity, capable of

producing an 8 ft. x 8 ft. x 16 ft. module of cotton (Case-IH). The John Deere 7760 is a 530 horsepower machine which forms harvested cotton into round bales wrapped with plastic. This is also a 6-row cotton picker, forming round modules of cotton up to 90 inches in diameter and 96 inches wide, with a module cotton weight of 4,500 to 5,500 pounds (John Deere).

John Deere Cotton Picker Model 7660   *John Deere Cotton Picker Model 7760*

Figure 1.1 John Deere Cotton Picker Models

Although the onboard module building cotton pickers have been on the market for several years, the purchase and adoption of these new harvest systems has been slow primarily due to their higher purchase price. However, over the past few years, some cotton producers have purchased and utilized these harvest systems in their farming operations. Now that some of these new onboard module cotton harvesters have been in use for a few years by some cotton producers in the southern cotton-producing region, more realistic assumptions can be made relative to their actual operating parameters compared to traditional basket pickers.

1.2 Problem Statement

In many respects, cotton production in Louisiana is at a crossroads. Much of the cotton currently planted in the state is by producers who have some beneficial interest in a cotton gin and are planting cotton to keep the gin in operation. At current levels of production cost and average market prices, cotton producers with above average yields are really the only producers who can adequately cover cotton production costs year-in and year-out. Net returns from the primary competing crops of corn and soybeans have been too great for cotton to economically compete for planted acreage at a significant level. With reductions in future federal commodity income support becoming a reality, resulting from ongoing farm bill negotiations, the economic viability of the state's cotton industry appears vulnerable unless something occurs to significantly alter the net return structure of the cotton production section in Louisiana. Onboard module building cotton harvesters offer the potential to lower harvest cost and thereby improve net returns from cotton production. Questions exist as to the extent by which adoption of this new harvest system can substantially alter the relative costs and returns structure of cotton production in the state and thereby improve its competitiveness with other major row crops for planted acreage in the state.

1.3 Review of Literature

The economic research planned as part of this project will focus primarily on the estimation of costs associated with the ownership and operation of onboard module building cotton harvesters as well as how any estimated differences in harvest costs associated with this new system impacts the relative profitability of cotton within traditional crop rotations sequences existing in the Louisiana. As a result, this review of literature focuses on economic research methodologies related to the economic evaluation of crop rotation systems, the production of

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cotton in a crop rotation system and previous economic work related to onboard module building cotton harvesters and also.

Crop rotation has been a long-standing agronomic practice. Regardless of the location of production or the particular crops included in rotation production sequence, agronomic, as well as economic, benefits have been widely observed from this practice. Crop rotation can be defined as a more or less regular recurrent succession of producing different crops on the same land (Kipps, 1970). Benefits of crop rotation include the control of weeds, insects and diseases, improving the organic matter of soils, aiding the supply of nitrogen in the soil, increasing crop yields, and minimizing crop income and price risk.

Modeling farm-level crop rotations requires recognition of particular basic constraints or relationships among crops, both within a single growing season as well as over several growing seasons, which must be accommodated for within the crop rotation modeling framework. Four basic crop rotation constraints or rules have been identified as necessary to properly model and evaluate the determination of crop rotation sequences (Castellazzi, et al., 2008). These rotation relationships include: (a.) minimum return period for production of the same crop, (b.) benefits and/or risks of production of one particular crop directly following production of another crop, (c.) within-year cycles relating the interrelationships between planting and harvesting of crops within a single production year, and (d.) overall proportions of crops produced on a set of fields over a portion or all of the production fields on the farm. These four basic rotation relationships have direct implications for modeling the specific rotation sequence choices, the agronomic and economic implications of specified crop sequences, as well as the defined crop rotation choice set over the entire farm.

Crop rotation models can vary regarding their primary variable of analysis or measure of performance. Previous rotation models have been developed to optimally manage production input balances, such as water or nitrogen (Salado-Navarro and Sinclair, 2009; Cavero, et al., 1999). Other investigations have focused on managing adverse consequences from crop production, such as soil-borne organisms or soil erosion (Taylor and Rodriguez-Kavana, 1999; Cabelguenne, et al., 1990). Still other crop rotations models have evaluated profitability in combination with production factors such as soil fertility, water use and soil quality (Dogliotto, et al. 2004; Popp, et al., 2005; Hulugalle, et al., 2002).

Crop rotation models can also vary regarding the specific type of modeling framework utilized. Many rotation models have utilized a linear programming framework (El-Nazar and McCarl, 1985; Haneveld and Stegeman, 2005). Linear programming provides a convenient and efficient means to specify and model the interrelationships of cropping sequences over a multi-year period. Other crop rotation modeling efforts have utilized dynamic programming (Taylor and Rodriguez-Kabana, 1999), multi-objective programming (Annetts and Audsley, 2002), or Markov chains (Aurbacher and Dabbert, 2011). An excellent review of cropping plan and crop rotation decision models is provided by Dury, et al. (2012).

Detlefsen and Jensen (2007) have proposed utilizing network flow models as a framework for determining optimal crop rotation sequences. They develop a multi-year maximum flow network optimization model in a transportation model format with sets of supply and demand nodes representing individual crop area totals, which can accommodate any number of prior crop years and any number of future production years. Simplified crop rotation models of this type, formulated as network models with only source nodes (crop area supply), sink nodes (crop area demand), and transshipment nodes (consecutive year crop sequence) have the advantage of being

able to be solved utilizing streamlined network optimization algorithms which can greatly reduce model programming and computation time. The disadvantages of utilizing this type of simple network model formulation includes the inability to incorporate side restrictions on specific crop area as well as ignoring the impact of market price and crop yield risk on optimal crop sequence choices.

Production of cotton in rotation with other crops has several advantages for both cotton and the rotational crop. Advantages in disease and weed control with crop rotation in many cases results in a yield advantage from rotational cotton production versus monoculture cotton production. Improved disease control in cotton production, specifically control of verticillium wilt, root-knot nematode and reniform nematode, is one of the most important reasons for rotation of other crops with cotton. With the tremendous expansion of production of herbicide resistant cotton varieties, preventing, or at least delaying, development of herbicide resistant weeds may be one of the most important advantages of a systematic rotation in cotton production. Over a longer time perspective, cotton production as a rotational crop has also shown benefits to soil properties, thereby improving productivity and profitability (Salinas-Garcia, et al., 1997; Wesley, et al., 2001; Balota, et al., 2004; Hulugalle and Scott, 2008).

The particular crops produced with cotton in a rotation system in the United States depends to some extent on where in the cotton region a farm is located. Corn and soybeans are probably the most commonly produced crops included in a cotton rotation. In the southeastern part of the U.S., corn and soybeans are major crops along with cotton. As a result, there are several advantages, relative to equipment availability, producer expertise, etc., of including these crops in cotton rotations. With the expansion of production of glyphosate-resistant varieties of cotton, corn and soybeans, weed control has been improved (Shaw, et al., 2009). However, the long-term

success of producing glyphosate-resistant crops in a rotation system will depend on the development of a multifaceted integrated weed management program that includes a combination of weed control measures (Kruger, et al., 2009). Other crops typically rotated with cotton in a crop production rotation system include peanuts, wheat and sorghum (Johnson, et al., 2001; Clark, et al., 1996; Booker, et al., 2007).

The Mid-South region is one of the four major cotton-producing regions in the United States. This production region spans the states of Arkansas, Louisiana, Mississippi, Missouri and Tennessee. In 2011, this region accounted for 24.4% of total U.S. harvested cotton acreage and 29.4% of total U.S. cotton production. For many years, much of the cotton produced in this region was produced in a monoculture system as continuous cotton. In the 1980's, noticing the decline in soil productivity of cotton land, scientists began to evaluate the impact of crop rotation on cotton production. Corn and soybeans were to two primary rotation crops evaluated with cotton production.

Ebelhar and Welch (1989) found that cotton produced in the Mid-South region produced significantly higher yields following one or two years of corn production compared with continuous cotton. Studies in several Mid-South states have verified that not only are cotton yields higher when produced in a crop rotation system, but the rotation crop, whether it is corn, soybeans, or sorghum, does not matter (Martin, et al., 2002; Boquet, et al., 2004; Boquet and Paxton, 2009). The response in cotton yield is similar in rotation. In addition, research in Louisiana has shown that the nitrogen requirement for cotton is reduced by 20 to 25 pounds per acre (Guidry, et al., 2001; Boquet, et al., 2001).

As total harvest costs comprise such a significant part of total cotton production costs, much research has been conducted over the years to evaluate not only the performance, but also

the costs of alternative cotton harvest systems and equipment configurations. A large amount of the economic research has evaluated the comparative costs of utilizing stripper versus picker harvest systems (Nelson, et al., 2000; Willcutt, et al., 2001; Yates, et al., 2007; Keeling, et al., 2011). Some of the early economic research evaluating the costs of onboard module building cotton harvest systems was conducted in Mississippi. Parvin (2005) estimated the operating costs of onboard module cotton pickers with traditional 4-row and 6-row cotton pickers. Although estimated cost for the onboard module picker was lower than traditional pickers, cost estimates for all systems were estimated using the same, assumed levels of harvest speed and hours of annual use. A later study estimated the harvest costs for the new onboard harvest systems on a per-pound of lint and per bale of cotton basis (Martin and Valco, 2008).

1.4 Objectives

The general objective of this study is to determine the economic impact of the adoption of the new onboard module building cotton harvest system on the economic competitiveness of cotton within the mixed crop farming areas of Louisiana. This will be achieved through the following specific objectives:

(1) Estimate fixed and variable costs associated with the use of onboard module building cotton harvesters and determine cost efficient cotton acreage levels based upon capital recovery cost estimates and economics of scale.

(2) Evaluate the impact of adoption of onboard module building cotton harvesters on optimal crop enterprise combinations of cotton, corn and soybeans under alternative crop yield and market price assumptions.

(3) Evaluate the impact of adoption of onboard module building cotton harvesters on risk efficient crop rotation sequences of cotton, corn and soybeans for alternative cotton producer risk preferences.

1.5 Methodology

This study focuses on the mixed crop farming area of northeast Louisiana. Major row crops to be evaluated in the analysis will include cotton, as the principal crop of interest, along with corn and soybeans, representing the major competing crops for planted acreage. The general objective of the research will be to evaluate how the adoption of onboard module building cotton harvesters can improve the economic competitiveness of cotton production within existing crop rotations sequences.

Objective 1 of this study will be achieved by developing estimates of the fixed and variable costs of cotton harvesting for the new onboard module building cotton pickers as well as the traditional basket cotton pickers which require the use of separate module builders. Preliminary cost estimates for module building cotton pickers will be developed from existing research currently underway in the Department of Agricultural Economics.   Published data for traditional basket pickers used in Louisiana will also be utilized to develop estimates of changes in fixed and variable cotton harvest costs associated with the adoption of the new harvest technology. Estimates of cost efficient cotton harvest acreage levels will be determined based upon performance rates and fixed cost parameters associated with the module building cotton pickers.

Objective 2 of this study will evaluate the impact of adoption of onboard module building cotton harvesters on optimal crop enterprise combinations of cotton, corn and soybeans under alternative crop yield and market price assumptions. This evaluation will be conducted using a simulation analysis based on a two-year crop rotational economic optimization model which has recently been developed in the Department of Agricultural Economics and Agribusiness (Salassi, et al., 2013). This prior study formulated the two-year crop rotation problem as a mathematical programming transshipment model with risk-adjusted side constraints, following Tauer's formulation of the Target MOTAD problem (1983). In the analysis presented here, simulation procedures will be utilized to more fully evaluate the impacts of commodity market price and production yield risk on crop rotation net returns for rotations utilizing alternative cotton harvest systems.

Simulation analysis of net returns from alternative crop rotations common in the cotton production area of Northeast Louisiana was performed by conducting a series of operations required to estimate and simulate net returns above variable costs for cotton utilizing alternative cotton harvest systems along with similar estimates for corn and soybeans as rotational crops. To estimate net returns for cotton production under alternative harvest systems, the following net return per acre function was specified:

$$NR_{cta} = P_{ct} Y_{ct} GR_{ct} - (N_{ct} P_N + P_{ct} P_P + K_{ct} P_K + F_{cta} P_F + IC_{ct} PIRG_{ct} + FLB_{cta} PFLB$$

$$+ OLB_{cta} POLB + OTHVC_{cta}) \tag{1.1}$$

where NR_{cta} is the net return above variable costs per acre for cotton production (*ct*) utilizing harvest system *a*, P_{ct} is the market price of cotton lint in dollars per pound, Y_{ct} is the yield per acre

of cotton lint, GR_{ct} is the grower's share of the crop under a crop share rental arrangement (80% in this analysis), N_{ct} is the quantity of nitrogen fertilizer applied in pounds of active ingredient per acre, P_N is the cost of nitrogen fertilizer in dollars per pound of active ingredient, P_{ct} is the quantity of phosphorus fertilizer applied in pounds of active ingredient per acre, P_P is the cost of phosphorus fertilizer in dollars per pound of active ingredient, K_{ct} is the quantity of potash fertilizer applied in pounds of active ingredient per acre, P_K is the cost of potash fertilizer in dollars per pound of active ingredient, F_{cta} is the quantity of diesel fuel used in gallons per acre, P_F is the cost of diesel fuel in dollars per gallon, IC_{ct} is the variable nonfuel cost of irrigation in dollars per acre, $PIRG_{ct}$ is the percent of the crop irrigated, FLB_{cta} is the required field labor in hours per acre, $PFLB$ is the cost of field labor in dollars per hour, OLB_{cta} is the required operator labor in hours per acre, $POLB$ is the cost of operator labor in dollars per hour, and $OTHVC_{cta}$ is other variable costs in dollars per acre.

Similar net return equations were specified for corn and soybeans, crops commonly produced in rotation with cotton. These net return above variable cost equations for corn (*cr*) and soybeans (*sb*) were specified as follows:

$$NR_{cr} = P_{cr}\,Y_{cr}\,GR_{cr} - (N_{cr}\,P_N + P_{cr}\,P_P + K_{cr}\,P_K + F_{cr}\,P_F + IC_{cr}\,PIRG_{cr} + FLB_{cr}\,PFLB$$

$$+ \; OLB_{cr}\,POLB + OTHVC_{cr}) \tag{1.2}$$

$$NR_{sb} = P_{sb}\,Y_{sb}\,GR_{sb} - (N_{sb}\,P_N + P_{sb}\,P_P + K_{sb}\,P_K + F_{sb}\,P_F + IC_{sb}\,PIRG_{sb} + FLB_{sb}\,PFLB$$

$$+ \; OLB_{sb}\,POLB + OTHVC_{sb}) \tag{1.3}$$

where NR_{cr} and NR_{sb} are the net return above variable costs for corn (*cr*) and soybean (*sb*) production, respectively, P_{cr} and P_{sb} are the market prices of corn and soybeans in dollars per bushel, Y_{cr} and Y_{sb} are the yields of corn and sobyeans in bushels per acre. All other cost variables are defined in a manner similar to that of cotton in equation (1.1). Variable production cost estimates for cotton, corn and soybeans were based on projected values for the 2013 crop year based on a report by Deliberto and Salassi (2013).

In the simulation analysis, specific commodity price, crop yield and input cost values were selected to be random values and were simulated using a multivariate empirical algorithm developed by Richardson, et al., (2000). Random values simulated in the analysis included the market price and yield per acre of cotton, corn and soybeans as well as input prices for diesel fuel, and nitrogen, phosphorus, and potash fertilizer. *Simetar*, a commercial mathematical simulation software package (Richardson, et al., 2008) was utilized in this research to simulate random values based on historical data. This algorithm utilizes an estimated correlation matrix of deviations from the historical means of the random variables being simulated as well as user specified means of projected distributions of random variables. Historical data for cotton, corn and soybean production in Tensas Parish, Louisiana, along with prices for diesel fuel, nitrogen, phosphorus and potash fertilizer over the 2003-2012 period were utilized in generating the random distributions of these variables. In this study, a total of 1,000 randomly simulated values for crop market prices and yields, as well as fuel and fertilizer input prices were developed and utilized to estimate values of net returns above variable production costs for alternative crop rotations.

Under this objective, average net returns for specified alternative two-year crop rotations will be estimated using the following net return equation:

$$NR_T = [NR_{i,1,j} + NR_{j,2,i}] / 2 \tag{1.4}$$

where NR_T represents the average net return above variable cost per acre per year for a two-year crop rotation sequence T, $NR_{i,1,j}$ represents the expected net return above variable cost per acre of crop i planted in year 1 in rotation with crop j, and $NR_{j,2,i}$ represents the expected net return per acre of crop j planted in year 2 in rotation with crop i. Stochastic net returns for each crop rotation under alternative mean levels of crop yields and market prices will be simulated using a procedure developed by Richardson, et al. (2000) and available in the software package *Simetar* (Richardson, et al., 2008).

Objective 3 of this study will evaluate the impact of adoption of onboard module building cotton harvesters on risk efficient crop rotation sequences of cotton, corn and soybeans for alternative cotton producer risk preferences with comparisons made to similar crop rotation sequences which utilize the traditional basket cotton pickers. Stochastic efficiency with respect to a function (SERF) will be utilized in conducting this analysis. Stochastic efficiency with respect to a function was originally proposed by Hardaker and Lien (2003) as a means to evaluate a set of risky alternatives in terms of certainty equivalents for a specified range of risk preferences. The advantage of this procedure lies in its ability to compare the entire set of risky alternatives available to the decision maker, rather than the pairwise comparisons which are made by other risk analysis procedures such as stochastic dominance with respect to a function (SDRF).

The impact of switching to an onboard module building cotton harvest system from traditional basket pickers will be evaluated by estimating the certainty equivalent of a specific risk crop rotation sequence over a specific range of risk aversion parameters and making comparisons with certainty equivalents for other crop rotation sequences without cotton and/or crop rotation

sequences utilizing traditional basket cotton pickers. A negative exponential utility function, commonly used in the field of agricultural economics to represent a decision maker's utility for wealth related to risky choices, will be utilized (Schumann, et al., 2004). Calculation of the certainty equivalents and comparison over alternative risky crop rotation sequence alternatives will be conducted using an Excel based approach developed by (Hardaker, et al., 2004). Distributions of net returns evaluated under this study objective will be those estimated under objective 2.

The certainty equivalent (CE) of a risky choice is an estimated value at which the decision maker would be indifferent between the estimated certainty equivalent and the risky choice. The estimation of certainty equivalents are dependent upon the choice of utility function employed. This study will utilize a negative exponential utility function, commonly used for decision risk analysis choices. A negative exponential utility function may be expressed mathematically as:

$$U(w) = -exp(-r_a \, w) \qquad (1.5)$$

where U represents a measure of utility from a given choice or decision, w represents the wealth or income associated with that choice and r_a represents a specific absolute risk aversion coefficient. The absolute risk aversion coefficient is a means of measuring the degree of risk aversion by a decision maker faced with a risky decision choice. An absolute risk aversion coefficient is defined as the negative ratio of the second and first derivatives of a wealth utility function and basically serves as a measure of the curvature of a utility function (Anderson, et al., 1977).

Within this type of risk analysis, a decision arises regarding the appropriate values and range of absolute risk aversion coefficients to evaluate for a given risky decision choice. One

methodology to address this issue is to evaluate the relationship between absolute and relative risk aversion (Hardaker, et al., 2004). This relationship may be expressed mathematically as follows:

$$r_a(w) = r_r(w)/w \tag{1.6}$$

where r_a is the absolute risk aversion coefficient, r_r is the relative risk aversion coefficient and w is the wealth from a given risky choice. Anderson and Dillon (1992) have proposed a general classification range of relative risk aversion coefficients in the range of 0.0 for no risk, 0.5 for very little risk, and an upper value of approximately 4.0 for very risky choices. Absolute risk aversion coefficients to be utilized in this analysis will be obtained by dividing a range of relative risk aversion coefficients (0.0 to 4.0) by the estimated net return per acre for alternative crop rotation choices.

The certainty equivalents for alternative crop rotation choices and absolute risk aversion coefficients will then be estimated using the following relationship as outlined by Hardaker, et al., 2004:

$$CE(w, r_a(w)) = ln\left\{\left(\frac{1}{n}\sum_{i}^{n}\exp(-r_a(w)w_i)\right)^{-1/r_a(w)}\right\} \tag{1.7}$$

The analysis here will focus on the impact of lower estimated cotton harvest costs, associated with utilization of new onboard module cotton pickers, on the certainty equivalents of crop rotations including cotton and on the change in competitiveness of cotton for planted acreage. Estimated certainty equivalent values for alternative crop rotation alternatives will be plotted, with comparisons made regarding which specific crop rotation choices dominate other choices. More

specifically, certainty equivalent plots will be evaluated to identify how dominant crop rotation choices change as the degree of risk aversion changes.

CHAPTER 2. COTTON HARVEST SYSTEM COST ESTIMATION

In order to evaluate the impact of adopting a new cotton harvest system on the economic competitiveness of cotton production, comparative estimates of variable and fixed harvest system costs must be developed. Objective 1 of this study involves the estimation of variable and fixed cotton harvest system costs for the 6-row onboard module building harvest system compared with the traditional 4-row and 6-row basket cotton harvest systems. This chapter presents the results of the comparative estimation of cotton harvest system costs which will form the base level of cost data to be utilized in the succeeding analysis of alternative crop rotation choices.

2.1 Harvest Unit Performance Rates

The specification of machine performance rate is central to the accurate estimation of the variable costs of operating harvest units such as cotton pickers. Performance rates are a statement of machine capacity per unit of time and are typically stated in units of number of acres covered (harvested) per hour of operation. The effective field capacity or performance rate of a specific harvest unit is a function of primarily two values: the theoretical field capacity of the machine as well as an adjustment for field efficiency (John Deere).

Effective field capacity, in acres harvested per hour of operation, for a cotton picker can be estimated by using the following formula:

$$EFC = \frac{FS \times MW}{8.25} \times FE \qquad\qquad (2.1)$$

where EFC = effective field capacity in acres per hour, FS = machine field speed in miles per hour, MW = machine width in feet, FE = field efficiency in percent, and 8.25 is the ratio between 5,280 feet per mile and 43,560 square feet per acre.

Table 2.1 presents estimates of effective field capacity (i.e., performance rates) for a 4-row and 6-row traditional basket picker as well as a new 6-row module picker. Two key parameters in these estimates, field speed and field efficiency, are based on producer estimates of what are actually observed under field conditions in southern U.S. cotton production. The basket pickers operate at about 70 percent field efficiency at speeds of 3.6 (4-row) and 4.2 (6-row) miles per hour. Growers with newer onboard module building pickers indicated that they could run their machines at about 5 miles per hour. A more conservative field speed of 4.8 miles per hour was used in this analysis. Growers also indicated that the field efficiency was greater for the onboard module pickers, in the range of 80 to 85 percent.

The resulting performance rates estimated here for the three types of cotton pickers correlated closely with information indicated by the cotton producers from field experience. The 4-row basket picker had an estimated harvest performance rate of 3.89 acres per hour (0.257 hours per acre) and the 6-row basket picker had an estimated performance rate of 6.77 acres per hour (0.148 hours per acre). The estimated harvest performance rate for the 6-row module picker was 9.40 acres per hour (0.106 hours per acre). This value was within the range of potential harvest ability of approximately 8 to 10 acres per hour, depending upon conditions, indicated by the growers currently operating module cotton pickers. Fuel and labor costs for operation of the module picker alone were estimated to be higher than the basket pickers on a cost per hour of operation basis ($92.26 per hour). However, the increased field efficiency and potential greater harvest speed resulted in a lower estimated harvest machine cost on a per harvested acre basis,

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Table 2.1 - Cotton Picker Field Performance Rates and Fuel and Labor Costs

Cotton Harvest Unit Performance Rate and Variable Cost	Basket Picker 4-row	Basket Picker 6-row	Module Picker 6-row
Operation Parameters:			
Field speed (mph) [FS]	3.6	4.2	4.8
Machine size (# rows)	4	6	6
Row width (inches)	38	38	38
Machine width (feet) [MW]	12.7	19.0	19.0
Field efficiency (%) [FE]	70	70	85
Fuel use (gal/hr)[1]	14.3	16.4	23.3
Performance Rates:			
Acres per hour	3.89	6.77	9.40
Hours per acre	0.257	0.148	0.106
Variable Costs:			
Labor cost per hour[2]	15.30	15.30	15.30
Fuel cost per hour[3]	47.19	54.15	76.96
Total fuel and labor cost per hour	62.49	69.45	92.26
Total fuel and labor cost per acre	16.06	10.26	9.82

[1] Fuel use based on a factor of 0.044 gal/hp-hr.
[2] Harvest machine operator labor charged at a rate of $15.30 per hour.
[3] Fuel cost based on a diesel price of $3.50/gal.

compared with the basket pickers. Fuel and labor cost per acre for the module picker and a single operator were estimated to be $9.82 per acre, compared to $16.06 and $10.26 for the 4-row and 6-row basket pickers.

One area of interest regarding the operating costs of the new module cotton pickers is the relationship between harvest field speed and field efficiency. It is generally assumed, and initial field experience suggests, that the module pickers can be operated at a slightly greater harvest speed and will perform with a greater harvest field efficiency than the traditional basket pickers. With traditional basket pickers, the harvest unit would move through the field harvesting cotton. When the basket would fill to its capacity with harvested cotton lint, the picker would stop in the field, a field tractor would bring a boll buggy alongside for the harvested lint to be emptied into

for transport to a module builder. Harvest performance rates for these types of pickers are in the range of 3 to 4 acres per hour for a 4-row picker and 6 to 7 acres per hour for a 6-row picker. The advantage offered by the newer onboard module pickers is not only the significant reduction in harvest labor required, but also the increase in harvest performance and efficiency due to the reduction in time required to unload harvested cotton from the picker to the boll buggy. When the onboard module capacity is reached during harvest, the picker unloads the wrapped cotton module on the ground and continues harvesting. The only other labor and machinery required to harvest the cotton is a field tractor and operator which moves the modules to loading sites, operating independently of the module harvester. Some growers have indicated that on large tracts of cotton, one field tractor moving harvested cotton modules can provide adequate harvest support to two module pickers.

Table 2.2 presents estimates of the expected range of fuel and labor costs for the onboard module picker over alternative ranges of field speed and field efficiency which would most likely be observed under actual harvest field conditions. Under normal operating harvest conditions, the module picker has the potential to operate at 80% to 90% field efficiency with harvest speeds of 4.6 to 5.0 miles per hour. Over this range of harvest performance, it is estimated that the module picker could harvest cotton at rates of 8.47 to 10.36 acres per hour. Even when operating at slightly lesser field efficiency or slower harvest speed, the harvest capacity of the module picker, in terms of acres harvested per hour, would still be expected to be equal to or greater than the harvest capacity of comparable sized basket pickers.

For the predicted range of module picker harvest parameters, 4.6 to 5.0 mile per hour harvest speed and 80% to 90% field efficiency, harvest machine fuel and labor cost were estimated to range from $8.90 to $10.89 per acre harvested. These cotton picker harvest cost estimates are

Table 2.2 – Onboard Module Picker Performance Rates and Variable Costs
Under Alternative Field Speeds and Field Efficiencies

(1) Acres per Hour

				Field Speed (mph)			
		4.0	4.2	4.4	4.6	4.8	5.0
	70%	6.45	6.77	7.09	7.42	7.74	8.06
Field	75%	6.91	7.25	7.60	7.94	8.29	8.64
Efficiency	80%	7.37	7.74	8.11	8.47	8.84	9.21
(%)	85%	7.83	8.22	8.61	9.00	9.40	9.79
	90%	8.29	8.70	9.12	9.53	9.95	10.36

(2) Hours per Acre

				Field Speed (mph)			
		4.0	4.2	4.4	4.6	4.8	5.0
	70%	0.155	0.148	0.141	0.135	0.129	0.124
Field	75%	0.145	0.138	0.132	0.126	0.121	0.116
Efficiency	80%	0.136	0.129	0.123	0.118	0.113	0.109
(%)	85%	0.128	0.122	0.116	0.111	0.106	0.102
	90%	0.121	0.115	0.110	0.105	0.101	0.097

(3) Fuel & Labor Cost per Acre[1]

				Field Speed (mph)			
		4.0	4.2	4.4	4.6	4.8	5.0
	70%	14.31	13.63	13.01	12.44	11.92	11.45
Field	75%	13.35	12.72	12.14	11.61	11.13	10.68
Efficiency	80%	12.52	11.92	11.38	10.89	10.43	1002
(%)	85%	11.78	11.22	10.71	10.25	9.82	9.43
	90%	11.13	10.60	10.12	9.68	9.27	8.90

[1] Fuel use based on a factor of 0.044 gal/hp-hr for a 530 hp module cotton picker. Fuel cost based on a diesel price of $3.50/gal. Harvest machine operator labor charged at a rate of $15.30 per hour.

approximately $4 to $6 per acre less than cost estimates for a comparably sized basket picker. The primary factor resulting in this lower variable harvest cost is related to the higher harvest performance rates experienced with the module pickers.

2.2 Total Harvest System Costs

Comparative total per acre cotton harvest system costs are presented for the 4-row and 6-row basket pickers (Table 2.3 and 2.4) and for the 6-row onboard module system (Table 2.5). These estimated costs include charges for all labor and equipment utilized in harvesting the cotton

Table 2.3 – Total Cotton Harvest Costs per Acre for a 4-Row Basket Picker

	Fixed	Fuel	Repairs	Labor	Total
	Dollars per harvested acre				
Cotton picker – 4-row basket picker[1,2]	61.11	12.86	15.26	6.40	95.63
Boll buggy	3.62	--	1.68	--	5.30
Boll buggy tractor	6.83	8.79	1.71	2.47	19.80
Module builder	4.21	--	1.96	--	6.17
Module builder tractor	6.83	8.79	1.71	4.93	22.23
Total harvest cost per acre	*$82.61*	*$30.44*	*$22.32*	*$13.80*	*$149.17*

[1] Cotton picker capital fixed costs based on 200 hours of annual use.
[2] Cotton picker labor cost includes charges for an operator and one field laborer.

Table 2.4 – Total Cotton Harvest Costs per Acre for a 6-Row Basket Picker

	Fixed	Fuel	Repairs	Labor	Total
	Dollars per harvested acre				
Cotton picker – 6-row basket picker[1,2]	28.64	8.50	6.66	3.69	47.49
Boll buggy	1.67	--	0.78	--	2.44
Boll buggy tractor	3.94	5.06	0.98	1.42	11.40
Module builder	2.23	-	1.04	--	3.26
Module builder tractor	3.94	5.08	0.98	2.84	12.84
Total harvest cost per acre	*$40.41*	*$18.64*	*$10.44*	*$7.95*	*$77.43*

[1] Cotton picker capital fixed costs based on 250 hours of annual use.
[2] Cotton picker labor cost includes charges for an operator and one field laborer.

Table 2.5 – Total Cotton Harvest Costs per Acre for a 6-Row Module Picker

	Fixed	Fuel	Repairs	Labor	Total
	Dollars per harvested acre				
Cotton picker – 6-row module picker[1,2]	26.21	8.65	6.10	1.78	42.74
Round bale hauler tractor	2.82	3.64	0.70	1.53	8.69
Total harvest cost per acre	*$29.03*	*$12.29*	*$6.80*	*$3.31*	*$51.43*

[1] Cotton picker capital fixed costs based on 250 hours of annual use.
[2] Cotton picker labor cost includes charges for an operator.

crop. The two basket picker systems include fixed and variable costs associated with a separate traditional module builder. For each harvest system, including the module picker, an additional field laborer is charged to cover additional harvest labor not directly associated with field machine operation. This labor charge per acre is based on the performance rate of the particular cotton picker.

Estimated total harvest system cost for the onboard module system was estimated at $51.43 per harvested acre, compared with $149.17 and $77.43 for the two basket picker systems. This cost was based on more realistic operating assumptions including 250 hours of annual use as well as the slightly higher harvest speed and field efficiency. Only two machine operators are required for the onboard module building harvester, one person to operate the module picker and another person to operate a tractor moving the module bales to a transport location. The $26.21 per acre fixed capital cost for the module picker is based on an assumed purchase price of $575,000 with a useful life of 10 years and 250 hours of annual use per year. Higher value harvest machines with greater field capacity are going to have to be used over more acres on an annual basis to realize the potential economic advantages possible.

2.3 Impact of Annual Use on Fixed Cost

In addition to the field capacity or performance rate which directly impact variable harvest costs per acre, the economically efficient use of harvest machinery is also dependent upon the amount of annual use of the machine which directly impacts fixed harvest costs per acre harvested. By definition, total annual fixed costs associated with owning harvest machinery is constant. However, the economically efficient use of that machinery implies that it is used over a large

enough acreage in a given year in order to lower fixed costs per acre down to a low enough level to make the use that harvest equipment economical for the grower.

Capital recovery cost estimation is a method of calculating the annual depreciation and interest charges related to the ownership of farm equipment. It is an alternative and more concise means of calculating equipment ownership costs than the traditional procedure of calculating depreciation and interest separately. The capital recovery amount is the annual payment that will recover the initial investment lost through depreciation, plus interest on the investment (Kay, Edwards and Duffy). This amount will also generally be slightly higher than the sum of average annual depreciation and interest, calculated separately, because the capital recovery method assumes that interest charges are computed at the beginning of each year and are compounded annually. The capital recovery factor is a function of the interest (i) and the number of years of expected useful lift (n) and can be computed by either of the two often stated formulas below:

$$CRF \ = \ \frac{i(1+i)^n}{(1+i)^n-1} \ = \ \frac{i}{1-(1+i)^{-n}} \tag{2.2}$$

where *CRF* represents the annual capital recovery factor for a machinery investment of *n* years at an annual interest rate of *i*%.

Once the capital recovery factor is determined, the annual capital fixed cost of ownership of a piece of farm machinery can be computed by using the formula below:

$$CRCPY \ = \ [(RC - SV) \times CRF)] + (SV \times IR) \tag{2.3}$$

where *CRCPY* = the annual capital recovery charge (or fixed ownership cost) per year, *RC* = the replacement cost or purchase price of the equipment, *SV* = the salvage value, *CRF* = the calculated cost recovery factor and *IR* = the interest rate. For purposes of the cotton harvest cost analysis presented in this article, comparable annual capital recovery charges were estimated for a 6-row module picker and a 6-row basket picker. For the module picker, using a purchase price of $575,000, a 10-year useful life, a salvage value of 30% and an intermediate term interest rate of 5.25%, the capital recovery factor was calculated to be 0.13108 yielding an annual capital recovery cost of $61,817. For the 6-row basket picker, a purchase price of $450,000 was assumed, with all other parameters the same as for the module picker. The annual capital recovery cost for the basket picker was estimated to be $48,378.

Fixed cost values were estimated for a 6-row module picker and a comparable 6-row basket picker for specific hours of annual use; as for the module picker the costs are higher than a basket picker in a dollar per hour basis. However, the difference in fixed cost per hour of operation declines as annual operation hours increase. At 200 hours of annual use, fixed cost for the module picker was estimated at $309 per hour, compared with $242 per hour for the basket picker, a difference of $67 per hour. At 300 hours of annual use, fixed cost for the module picker was estimated at $206 per hour, compared with $141 per hour for the basket picker.

Given the difference in performance rates between the two cotton pickers, the 6-row module picker can harvest significantly more cotton acres over the same amount of time than the 6-row basket picker can. As indicated in Table 2.1, a 6-row module picker can harvest approximately 9.40 acres per hour, 2.63 acres per hour more than the 6-row basket picker. Therefore, at 200 hours of annual use, the module picker could harvest 535 more acres of cotton annually than the basket picker. At 300 hours of annual use, an additional 803 acres of cotton

could be harvested by the module picker. This increased harvest efficiency and capacity negates the differences in fixed cost per hour of operation. On a cost per acre harvested basis, fixed costs for the module picker at specific hours of annual use are within $4 per acre or less when compared to a comparable basket picker.

Table 2.6 provides estimates of fixed costs for specific hours of annual use ranging between 150 and 300 hours per year. On a cost per hour basis, estimated fixed costs for the module cotton picker are higher than for a comparable basket picker. For example, at 250 hours of annual use, the fixed cost for the module picker is estimated at $247 per hour, compared to a cost estimate of $194 per hour for the basket picker. However, given the increased field efficiency of the module picker, more acres can be harvested per hour of use by the module picker compared with the basket picker. At 250 hours of annual use, the module picker can harvest 2,358 acres of cotton, compared to just 1,689 acres with the basket picker. As a result, estimated fixed costs per acre harvested were lower for the module picker at all levels of annual use time. Differences in fixed costs ranged from about $4 per acre at lower hours of annual use to about $2 per acre for higher hours of annual use.

Table 2.7 provides comparable estimates of fixed costs and hours of annual use required to harvest specific levels of cotton acreage annually. At 1,400 acres of cotton harvested annually, fixed cost estimates for the module picker were $44 per harvested acre, approximately $9 per acre higher than for the basket picker. However, the module picker would require only 148 hours of operation to harvest that level of cotton acreage, 59 hours less than what would be required with the basket picker. The savings in variable operating cost would more than cover the slight increase in fixed cost per acre. Fixed cost per harvested acre decline significantly for higher specific annual acres of cotton harvested.

Table 2.6 – Estimated Fixed Capital Ownership Costs for 6-Row Cotton Pickers
For Alternative Hours of Annual Harvest Machine Use

Hours of Annual Use	Capital Recovery Per Hour of Use		Estimated Annual Acres Harvested		Capital Recovery Per Harvested Acre	
	Basket Picker[1]	Module Picker[2]	Basket Picker	Module Picker	Basket Picker	Module Picker
(hours)	--------($/hour)--------		--------(acres)--------		--------($/acre)--------	
150	323	412	1,014	1,415	48	44
175	276	353	1,182	1,651	41	37
200	242	309	1,351	1,887	36	33
225	215	275	1,520	2,123	32	29
250	194	247	1,689	2,358	29	26
275	176	225	1,858	2,594	26	24
300	161	206	2,027	2,830	24	22

[1] Capital recovery costs based on a $450,000 purchase price, 10 years of useful life, 30% salvage value, 5.75% interest rate, and performance rate of 0.148 hours per acre.
[2] Capital recovery costs based on a $575,000 purchase price, 10 years of useful life, 30% salvage value, 5.75% interest rate, and performance rate of 0.106 hours per acre.

Table 2.7 – Estimated Fixed Capital Ownership Costs for a 6-Row Cotton Pickers
For Alternative Acreages of Cotton Harvested Annually

Annual Cotton Acres Harvested	Capital Recovery Per Harvested Acre		Estimated Hours of Annual Use		Capital Recovery Per Hour of Use	
	Basket Picker[1]	Module Picker[2]	Basket Picker	Module Picker	Basket Picker	Module Picker
(acres)	--------($/acre)--------		--------(hours)--------		--------($/hour)--------	
1,400	35	44	207	148	233	417
1,600	30	39	237	170	204	364
1,800	27	34	266	191	182	324
2,000	24	31	296	212	163	292
2,200	22	28	326	233	149	265
2,400	20	26	355	254	136	243
2,600	19	24	385	276	126	224

[1] Capital recovery costs based on a $450,000 purchase price, 10 years of useful life, 30% salvage value, 5.75% interest rate, and performance rate of 0.148 hours per acre.
[2] Capital recovery costs based on a $575,000 purchase price, 10 years of useful life, 30% salvage value, 5.75% interest rate, and performance rate of 0.106 hours per acre.

With the increased harvest capacity of these new module cotton pickers, annual acres of cotton harvested per machine would need to approach and possibly exceed 2,000 acres of cotton in order to achieve the necessary cost savings to make the module pickers affordable and thereby be adopted by large numbers of producers. If a farming operation is large enough, these cost savings can be achieved within the specific farming operation. In other cases, it may be necessary to custom harvest some additional cotton acreage on other farming operations, at a custom charge, in order to achieve the desired cost savings. Given the fact these new onboard module building cotton pickers will most likely need to be utilized over more acres to lower fixed costs and the fact that these machines could be utilized within a single farming operation, for farms with large acreages of cotton, or utilized over multiple farming operations, for farms with smaller acreages of cotton, the analysis in the following chapters will focus on comparative net returns above variable costs as a means of evaluating the impact of this new cotton harvest system on the economic competitiveness of cotton for production acres within a farm or local production area.

Table 2.8 provides the cotton production by acres harvested in Louisiana during year 2012. A total of 14 farms have an acreage level in a range of 2,000 acres or more, implying that can adopt the module picker ; while 39 farms are producing between 1,000 to 1,999 acres. These are possible farms able to utilize the module picker over farming operations at a custom charge.

Tables 2.9 and 2.10 provide the corn, and soybean production during the same year. Farms in Louisiana producing corn, and soybean above the 2,000 acres totaling 27 and 82, respectively. These farms can implement a crop rotation system along with cotton while harvesting with a module picker, and meet the cost savings goal. Meanwhile, a higher number of farms 137 for corn, and 272 for soybean are producing in a range of 1,000 to 1,999 acres. These farms can adopt a rotation system along with cotton, and utilize the module picker over multiple farming operations.

Table 2.8 – Cotton Production by Size of Acres Harvested, Louisiana, 2012[1]

Acres harvested	Farms	(%)	Acres	(%)	Production[2]	(%)
1 to 249 acres	180	38.5	21,599	9.5	43,056	9.0
250 to 499 acres	131	28.1	45,667	20.1	95,318	20.0
500 to 999 acres	103	22.1	70,017	30.9	142,023	29.8
1,000 to 1,999 acres	39	8.4	50,890	22.4	111,830	23.5
2,000 acres or more	14	3.0	38,545	17.0	84,143	17.7
Total	467	100.0	226,718	100.0	476,370	100.0

[1]2012 Census of Agriculture, USDA. [2] Bales

Table 2.9 – Corn Production by Size of Acres Harvested, Louisiana, 2012[1]

Acres harvested	Farms	(%)	Acres	(%)	Production[2]	(%)
1 to 249 acres	403	39.9	41,370	7.9	6,688	7.3
250 to 499 acres	215	21.3	76,639	14.6	12,902	14.0
500 to 999 acres	227	22.5	155,846	29.7	27,520	29.9
1,000 to 1,999 acres	137	13.6	178,281	34.0	32,332	35.1
2,000 acres or more	27	2.7	71,872	13.7	12,575	13.7
Total	1,009	100.0	524,008	100.0	92,016	100.0

[1]2012 Census of Agriculture, USDA. [2] 1,000 bushels

Table 2.10 – Soybean Production by Size of Acres Harvested, Louisiana, 2012[1]

Acres harvested	Farms	(%)	Acres	(%)	Production[2]	(%)
1 to 249 acres	730	37.8	74,152	6.7	3,010	5.8
250 to 499 acres	402	20.8	142,353	12.8	6,161	12.0
500 to 999 acres	447	23.1	302,171	27.1	13,686	26.6
1,000 to 1,999 acres	272	14.1	369,543	33.2	17,523	34.0
2,000 acres or more	82	4.2	225,431	20.2	11,088	21.5
Total	1,933	100.0	1,113,650	100.0	51,468	100.0

[1]2012 Census of Agriculture, USDA. [2] 1,000 bushels

CHAPTER 3. EVALUATION OF COTTON HARVEST SYSTEM COST CHANGES ON OPTIMAL CROP ROTATION NET RETURNS

This chapter presents results from a simulation analysis of the impact of changes in cotton harvest system costs related to the adoption of the onboard module harvest system on the estimated average net returns of alternative crop rotation choices. Average net returns per year above land rent and variable production costs were estimated for alternative two-year crop rotation options involving cotton, utilizing one of three types of cotton harvest systems: 4-row basket pickers, 6-row basket pickers and 6-row module pickers, along with corn and soybeans. In order to evaluate the impacts of alternative levels of mean commodity market prices and crop yields, three alternative levels of mean commodity market prices and two alternative levels of mean crop yields are analyzed. For each crop rotation option, the mean, standard deviation and 80% confidence range of average net returns estimates are presented for all market price and crop yield scenarios evaluated.

3.1 Estimation of Crop Rotation Net Returns

Considering a given farming operation, the estimated net returns values utilized to evaluate the impact of the use of onboard module building cotton pickers within a crop rotation system were defined as net grower returns above land rent and variable production costs. For this analysis, Tensas Parish was selected as the study location since much of the cotton produced in Louisiana is located in that parish. Commodity market price and crop yield history for cotton, corn and soybeans were based on a 10-year period data set from 2003 to 2012, as shown in Table 3.1, grain market prices have a tendency to increase simultaneously over the period analyzed.

Table 3.1 – Louisiana Cotton, Corn and Soybean Market Prices and Yields, 2003-2012[1]

Scenario	Cotton Yield	Cotton Price	Corn Yield	Corn Price	Soybean Yield	Soybean Price
	(lbs/acre)	*($/lb)*	*(bu/acre)*	*($/bu)*	*(bu/acre)*	*($/bu)*
2003	967	0.609	134	2.40	34	6.80
2004	867	0.414	135	2.45	33	6.29
2005	878	0.470	136	2.25	34	5.97
2006	946	0.461	140	2.80	36	5.94
2007	1,017	0.519	163	3.80	43	8.43
2008	576	0.524	144	4.45	33	9.52
2009	745	0.628	132	3.55	39	9.66
2010	842	0.810	140	3.90	41	10.50
2011	846	0.920	135	6.10	36	12.00
2012	1,020	0.693	173	6.90	46	14.70

[1] National Agricultural Statistics Service, USDA

In this study, cotton, corn and soybeans were assumed to be produced under a 20% crop share rental arrangement, with the grower's share of crop proceeds equal to 80%.

Under the above assumptions, equation 3.1 specifies the function used to simulate the net returns per acre for each crop.

$$NR_i = P_i Y_i GR_i - (N_i P_N + P_i P_P + K_i P_K + F_i P_F + IC_i PIRG_i + FLB_i PFLB$$

$$+ OLB_i POLB + OTHVC_i) \tag{3.1}$$

where NR_i is the net return above variable costs for crop i as defined for cotton, corn and soybeans in equations 1.1, 1.2, and 1.3, respectively. These net return estimates include a weighted cost of irrigation, with IC_i being the variable irrigation cost per acre and $PIRG_i$ being the percent of crop acres irrigated. For this study, the percentage of crop acres irrigated, based on estimates for 2012, were 30% for cotton and 40% for corn and soybeans.

The SIMETAR software package (Richardson, et al., 2008), was used to generate random values for the following variables: (P_i) commodity market price: cotton - dollars per pound of lint; corn – dollars per bushel; soybeans - dollars per bushel; (Y_i) crop yield: cotton – pounds of

lint per acre; corn – bushels per acre; soybeans – bushels per acre; (P_N) nitrogen fertilizer price in

dollars per pound of active ingredient; (P_P) phosphorus fertilizer price in dollars per pound of

active ingredient; (P_K) potash fertilizer price in dollars per pound of active ingredient; and (P_F)

fuel cost in dollars per gallon. A total of ten random variables were simulated in this analysis:

market prices for cotton, corn and soybeans, crop yields for cotton, corn and soybeans, and input

prices for nitrogen, phosphorus and potash fertilizer, along with diesel fuel. Historical crop

market prices were detrended for simulation purposes. No significant crop yield trends were

found for the time period evaluated. In each simulation scenario, a total of 1,000 values for each

random variable were generated. Mean input prices used for the simulation model were $0.56 per

pound for nitrogen, $0.65 per pound for phosphorus, $0.47 per pound for potash, and $3.50 per

gallon for diesel fuel. Two mean crop yield scenarios were simulated. Crop yield scenario A

represented yield levels that were approximately equal to the ten-year average yield for each crop.

Crop yield scenario B was included to evaluate the recent increases in cotton and corn yields.

Within each crop yield scenario evaluated, combinations of three alternative levels of commodity

market prices were simulated, representing mean levels of low, medium and high commodity

market prices.

3.2 Crop Yield Scenario A

For crop yield scenario A, base level monoculture crop yields for cotton, corn and soybean

were assumed to be 1,000 of cotton lint pounds per acre, 140 bushels per acre of corn and 40

bushels of soybeans per acre. These yield levels were chosen as they are approximately equal to

the previous ten-year (2003-2012) average crop yields for cotton, corn and soybean in Tensas

Parish. Crops grown in rotation with a different crop tend to have slightly higher yields compared

to monoculture crop production. Following research results from Boquet, et al. (2004), cotton yields were assumed to increase by 15% when grown in rotation with a different crop and corn and soybean yields were assumed to increase by 10% when grown in rotation with a different crop. Therefore, actual mean crop yield levels simulated in this study for cotton, corn and soybeans grown in a two-year rotation with a different crop were assumed to be 1,150 lbs/acre for cotton, 154 bu/acre for corn and 44 bu/acre for soybeans. Given the fact that probably most of the historical yield data for these crops reflects the impacts of crop rotation to some extent, rotational yields simulated in this analysis would represent slightly above average yields.

As shown in Table 3.2, nine sets of alternative mean commodity market price levels were evaluated. Three specific levels of mean cotton market prices were used in this analysis: $0.70, $0.80, and $0.90 per pound. In addition, three alternative levels of mean grain market prices were utilized. Low, medium and high mean grain price levels for corn and soybeans evaluated in this study included $4.00 and $8.00 per bushel, $5.00 and $10.00 per bushel, and $6.00 and $12.00 per bushel, respectively. Within each crop market price scenario, the average net return per acre per year was calculated for each two-year crop rotation alternative.

Tables 3.3 through 3.11, present simulation results of mean net returns above variable costs and rent for the alternative mean commodity market price levels from the simulation results for all cotton harvest systems and crop rotations evaluated in this study. Within each table, the mean and standard deviation of average net returns per acre per year, along with the 80% confidence interval range, is presented for each two-year crop rotation on a dollar/acre/year basis. For each crop rotation name listed in the tables, crops included in the two-year rotation are identified as cotton (CT), corn (CR) and soybeans (SB). The three cotton harvest systems

evaluated in this simulation analysis are identified as 4-row basket picker (4R-B), 6-row basket picker (6R-B), and 6-row module picker (6R-M).

Table 3.2 – Mean Market Price and Crop Yield Levels Simulated Under Yield Level A

Scenario	Cotton Yield 1/	Cotton Price	Corn Yield 1/	Corn Price	Soybean Yield 1/	Soybean Price
	(lbs/acre)	*($/lb)*	*(bu/acre)*	*($/bu)*	*(bu/acre)*	*($/bu)*
1	1,150	$0.70	154	$4.00	44	$8.00
2	1,150	$0.70	154	$5.00	44	$10.00
3	1,150	$0.70	154	$6.00	44	$12.00
4	1,150	$0.80	154	$4.00	44	$8.00
5	1,150	$0.80	154	$5.00	44	$10.00
6	1,150	$0.80	154	$6.00	44	$12.00
7	1,150	$0.90	154	$4.00	44	$8.00
8	1,150	$0.90	154	$5.00	44	$10.00
9	1,150	$0.90	154	$6.00	44	$12.00

1/ Base level monoculture crop yields of 1,000 lbs/acre for cotton, 140 bu./acre for corn and 40 bu./acre for soybeans were assumed. Cotton, corn and soybean yields in rotation assumed to be 15%, 10% and 10% higher average yield levels.

Results indicate that the adoption of the 6-row module cotton harvester does improve the competitiveness of cotton production within alternative crop rotation systems. In Table 3.3, net returns from a cotton rotation sequence utilizing the 6-row module harvest system were greater than net returns from cotton rotation sequences using the 4-row or 6-row basket pickers. With a mean cotton market price of $0.70 per pound of lint in combination with low grain market prices, net returns were highest for cotton produced in rotation with corn. Mean net returns for the CT(6R-M)/CR rotation were estimated to be $63 per acre per year compared with $55 per acre per year for the CT(6R-B)/CR rotation and $40 per acre per year for the CT(4R-B)/CR rotation. Mean net returns per acre per year for cotton in rotation with soybeans were also greatest using the 6-row module harvest system, $30 per acre for the CT(6R-M)/SB rotation compared to $23 per acre for the CT(6R-B)/SB rotation and $8 per acre for the CT(4R-B)/SB rotation. However, with a

mean cotton market price of $0.70 per pound along with low grain market prices, net returns above variable costs and rent were relatatively low for all crop rotation sequences analyzed, leaving little returns to cover fixed costs and overhead.

Tables 3.4 and 3.5 present simulation results representing low cotton market prices in combination with mid-level and higher grain market prices. As the harvest cost differences between the three cotton harvest systems remain the same, the mean level of net return values are greater resulting from the higher simulated mean market prices for corn and soybeans, although the differences between net returns for alternative cotton harvest systems remains the same. Average net returns per acre per year for cotton produced in rotation with corn again have the highest values. With mean corn prices at $6.00 per bushel and mean soybean prices at $12.00 per bushel (Table 3.5), a corn/soybean rotation yields higher net returns than any of the cotton/soybean rotations, regardless of which cotton harvest system is utilized. Although the variable cost advantages exhibited by the cotton onboard module system does increase the net returns for crop rotations including cotton, alternative levels of corn and soybean market prices seem to potentially have a greater impact on mean net return values at low cotton market prices.

Tables 3.6 through 3.8 present simulation results for alternative crop rotations utilizing alternative cotton harvest systems at mid-level cotton market prices, mean price of $0.80 per pound of lint, and at low, mid and high grain market prices. At low and mid-level grain prices, all rotations including cotton resulted in higher net returns than the corn/soybean rotation. A cotton/corn rotation utilizing the 6-row module cotton harvest system resulted in the highest net return estimated at a mean of $110 per acre per year (Table 3.6). Replacing corn with soybeans in this particular rotation would reduce mean expected net returns to $77 per acre per year.

Table 3.3 – Mean Net Return Values per Acre for Price Scenario 1 – Yield Level A 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	*($/acre)*	*($/acre)*
CT(4R-B)/CR	40	83	-62 to 153
CT(6R-B)/CR	55	83	-47 to 168
CT(6R-M)/CR	63	83	-39 to 175
CT(4R-B)/SB	8	77	-87 to 111
CT(6R-B)/SB	23	77	-73 to 125
CT(6R-M)/SB	30	77	-66 to 132
CR/SB	-39	59	-110 to 40

1/ Mean commodity prices: cotton - $0.70/lb., corn - $4.00/bu., soybeans - $8.00/bu.
  Mean crop yields: cotton – 1,150 lbs./acre, corn – 154 bu./acre, soybeans – 44 bu./acre.

Table 3.4 – Mean Net Return Values per Acre for a Price Scenario 2 – Yield Level A 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	*($/acre)*	*($/acre)*
CT(4R-B)/CR	102	85	-4 to 217
CT(6R-B)/CR	117	85	11 to 231
CT(6R-M)/CR	124	85	18 to 239
CT(4R-B)/SB	43	79	-56 to 146
CT(6R-B)/SB	58	79	-41 to 161
CT(6R-M)/SB	65	79	-33 to 168
CR/SB	58	66	-23 to 146

1/ Mean commodity prices: cotton - $0.70/lb., corn - $5.00/bu., soybeans - $10.00/bu.
  Mean crop yields: cotton – 1,150 lbs./acre, corn – 154 bu./acre, soybeans – 44 bu./acre.

Table 3.5 – Mean Net Return Values per Acre for Price Scenario 3 – Yield Level A 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	*($/acre)*	*($/acre)*
CT(4R-B)/CR	163	87	55 to 282
CT(6R-B)/CR	178	87	70 to 298
CT(6R-M)/CR	186	87	77 to 305
CT(4R-B)/SB	78	81	-24 to 184
CT(6R-B)/SB	93	81	-9 to 199
CT(6R-M)/SB	101	81	-1 to 206
CR/SB	154	74	64 to 253

1/ Mean commodity prices: cotton - $0.70/lb., corn - $6.00/bu., soybeans - $12.00/bu.
  Mean crop yields: cotton – 1,150 lbs./acre, corn – 154 bu./acre, soybeans – 44 bu./acre.

At mid level grain prices, all crop rotations including cotton resulted in higher expected net returns than the corn/soybean rotation. Utilizing the cotton module harvest system, the CT(6R-M)/CR rotation had an estimated net return of $171 per acre and the CT(6R-M)/SB rotation has an estimated net return of $112 per acre.

Table 3.8 presents net return simulation results for alternative crop rotations utilizing alternative cotton harvest systems with cotton prices at $0.80 per pound and grain market prices at higher levels. At these assumed levels of mean crop market prices, cotton/corn rotations yielded the highest net returns, with the estimated net return of the CT(6R-M)/CR rotation at $233 per acre. However, with mean corn and soybean market price levels at $6.00 per bushel and $12.00 per bushel, respectively, the corn/soybean rotation (CR/SB) resulted in higher net returns per acre, $154 per acre per year, than any of the cotton/soybean rotations.

Tables 3.9 through 3.11 present net return simulation results assuming a mean cotton market price level of $0.90 per pound. At this market price level, crop rotations including cotton result in higher expected net returns than any of the corn/soybean rotations, even at high grain market prices. At low grain market prices (Table 3.9), estimated mean net returns for all crop rotations including cotton were greater than $100 per acre per acre, compared with an estimated net returns loss of $39 per acre per year for the corn/soybean rotation. At higher levels of grain market prices, crop rotations including cotton continue to yield higher net returns than a corn/soybean rotation. Once again, net return differences for a specific crop rotation over the three cotton harvest systems is due to the differences in cotton harvest system costs. In addition, changes in mean commodity market price levels were found to have a greater impact on changes in the levels of net returns values.

Table 3.6 – Mean Net Return Values per Acre for Price Scenario 4 – Yield Level A 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	*($/acre)*	*($/acre)*
CT(4R-B)/CR	87	88	-23 to 206
CT(6R-B)/CR	102	88	-7 to 221
CT(6R-M)/CR	110	88	1 to 228
CT(4R-B)/SB	55	82	-49 to 162
CT(6R-B)/SB	70	82	-33 to 177
CT(6R-M)/SB	77	82	-26 to 189
CR/SB	-39	59	-110 to 40

1/ Mean commodity prices: cotton - $0.80/lb., corn - $4.00/bu., soybeans - $8.00/bu.
  Mean crop yields: cotton – 1,150 lbs./acre, corn – 154 bu./acre, soybeans – 44 bu./acre.

Table 3.7 – Mean Net Return Values per Acre for Price Scenario 5 – Yield Level A 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	*($/acre)*	*($/acre)*
CT(4R-B)/CR	149	90	36 to 270
CT(6R-B)/CR	164	90	51 to 285
CT(6R-M)/CR	171	90	59 to 292
CT(4R-B)/SB	90	84	-16 to 198
CT(6R-B)/SB	105	84	-1 to 213
CT(6R-M)/SB	112	84	7 to 22
CR/SB	58	66	-23 to 146

1/ Mean commodity prices: cotton - $0.80/lb., corn - $5.00/bu., soybeans - $10.00/bu.
  Mean crop yields: cotton – 1,150 lbs./acre, corn – 154 bu./acre, soybeans – 44 bu./acre.

Table 3.8 – Mean Net Return Values per Acre for Price Scenario 6 – Yield Level A 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	*($/acre)*	*($/acre)*
CT(4R-B)/CR	210	91	98 to 333
CT(6R-B)/CR	225	91	110 to 350
CT(6R-M)/CR	233	91	117 to 357
CT(4R-B)/SB	125	86	16 to 237
CT(6R-B)/SB	140	86	32 to 252
CT(6R-M)/SB	147	86	39 to 259
CR/SB	154	74	-64 to 253

1/ Mean commodity prices: cotton - $0.80/lb., corn - $6.00/bu., soybeans - $12.00/bu.
  Mean crop yields: cotton – 1,150 lbs./acre, corn – 154 bu./acre, soybeans – 44 bu./acre.

Table 3.9 – Mean Net Return Values per Acre for Price Scenario 7 – Yield Level A 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	*($/acre)*	*($/acre)*
CT(4R-B)/CR	134	93	18 to 259
CT(6R-B)/CR	149	93	33 to 274
CT(6R-M)/CR	157	93	40 to 282
CT(4R-B)/SB	102	87	-9 to 214
CT(6R-B)/SB	117	87	6 to 229
CT(6R-M)/SB	124	87	14 to 236
CR/SB	-39	59	-110 to 40

1/ Mean commodity prices: cotton - $0.90/lb., corn - $4.00/bu., soybeans - $8.00/bu.
  Mean crop yields: cotton – 1,150 lbs./acre, corn – 154 bu./acre, soybeans – 44 bu./acre.

Table 3.10 – Mean Net Return Values per Acre for Price Scenario 8 – Yield Level A 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	*($/acre)*	*($/acre)*
CT(4R-B)/CR	196	94	75 to 322
CT(6R-B)/CR	211	94	90 to 337
CT(6R-M)/CR	218	94	97 to 344
CT(4R-B)/SB	137	89	23 to 252
CT(6R-B)/SB	152	89	38 to 267
CT(6R-M)/SB	159	89	46 to 274
CR/SB	58	66	-23 to 146

1/ Mean commodity prices: cotton - $0.90/lb., corn - $5.00/bu., soybeans - $10.00/bu.
  Mean crop yields: cotton – 1,150 lbs./acre, corn – 154 bu./acre, soybeans – 44 bu./acre.

Table 3.11 – Mean Net Return Values per Acre for Price Scenario 9 – Yield Level A 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	*($/acre)*	*($/acre)*
CT(4R-B)/CR	257	96	134 to 385
CT(6R-B)/CR	272	96	149 to 400
CT(6R-M)/CR	280	96	156 to 407
CT(4R-B)/SB	172	91	55 to 291
CT(6R-B)/SB	187	91	71 to 306
CT(6R-M)/SB	194	91	78 to 313
CR/SB	154	74	64 to 253

1/ Mean commodity prices: cotton - $0.90/lb., corn - $6.00/bu., soybeans - $12.00/bu.
  Mean crop yields: cotton – 1,150 lbs./acre, corn – 154 bu./acre, soybeans – 44 bu./acre.

3.3 Crop Yield Scenario B

For crop yield scenario B, slightly higher mean crop yields for cotton and corn were simulated to reflect recent trends in these particular crop yields over the past couple of years. Regarding the prices of cotton, corn, and soybean, these values were simulated at a lower, mid and higher level of crop prices, helding the same values utilized in the previous scenario A. In addition to this, the grain prices utilized in the analysis reflect the tendency of the last ten years, where grain prices have increased simultaneously over that period of time.

Table 3.12 presents the mean values of crop yield and commodity market price levels simulated under this scenario. Using monoculture crop yields of 1,200 pounds per acre for cotton and 160 bushels per acre for corn, rotational yields simulated here were 1,380 pounds per acre for cotton and 176 bushels per acre for corn. Rotational soybean yields were held the same at 44 bushels per acre and the same alternative sets of mean crop market price levels for corn, soybean, and cotton were utilized . For each price scenario, the average combined net return per acre per year was calculated for a two year basis. The purpose of this set of simulation analysis runs was to evaluate the impact of recently observed higher crop yields for cotton and corn on the economic competitiveness of alternative crop rotations.

Simulation results presented in Tables 3.13 through 3.21 reflect the significant increase in economic competitiveness for cotton produced in a rotation system at sustainably higher levels of mean cotton yield. In each of the various simulation analysis runs conducted at these higher yield levels, similar results were obtained.

In general, crop rotations including cotton and corn yielded higher net returns than other alternative rotations and the use of module building cotton harvest systems further enhanced expected net returns above variable costs and rent. Based upon the assumed set of crop yields and production costs included in this particular set of simulation runs, the mean level of crop market prices did not materially alter these general results. Looking at only mean net returns values, cotton/corn and cotton/soybean rotations generally yielded higher expected net returns than a corn/soybean rotation. These results would suggest that expected cotton yield is a primary factor influencing the economic competitiveness of cotton production, aside from mean commodity price levels.

Table 3.12 – Mean Market Price and Crop Yield Levels Simulated Under Yield Level B

Scenario	Cotton Yield 1/	Cotton Price	Corn Yield 1/	Corn Price	Soybean Yield 1/	Soybean Price
	(lbs/acre)	($/lb)	(bu/acre)	($/bu)	(bu/acre)	($/bu)
1	1,380	$0.70	176	$4.00	44	$8.00
2	1,380	$0.70	176	$5.00	44	$10.00
3	1,380	$0.70	176	$6.00	44	$12.00
4	1,380	$0.80	176	$4.00	44	$8.00
5	1,380	$0.80	176	$5.00	44	$10.00
6	1,380	$0.80	176	$6.00	44	$12.00
7	1,380	$0.90	176	$4.00	44	$8.00
8	1,380	$0.90	176	$5.00	44	$10.00
9	1,380	$0.90	176	$6.00	44	$12.00

1/ Base level monoculture crop yields of 1,200 lbs/acre for cotton, 160 bu./acre for corn and 40 bu./acre for soybeans were assumed. Cotton, corn and soybean yields in rotation assumed to be 15%, 10% and 10% higher average yield levels.

Table 3.13– Mean Net Return Values per Acre for Price Scenario 1 – Yield Level B 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	($/acre)	($/acre)
CT(4R-B)/CR	135	91	25 to 260
CT(6R-B)/CR	150	91	41 to 275
CT(6R-M)/CR	157	91	48 to 283
CT(4R-B)/SB	72	83	-27 to 187
CT(6R-B)/SB	87	83	-13 to 202
CT(6R-M)/SB	94	83	-5 to 209
CR/SB	-8	62	-82 to 75

1/ Mean commodity prices: cotton - $0.70/lb., corn - $4.00/bu., soybeans - $8.00/bu.
 Mean crop yields: cotton – 1,380 lbs./acre, corn – 176 bu./acre, soybeans – 44 bu./acre.

Table 3.14 – Mean Net Return Values per Acre for Price Scenario 2 – Yield Level B 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	($/acre)	($/acre)
CT(4R-B)/CR	205	92	92 to 332
CT(6R-B)/CR	220	92	172 to 348
CT(6R-M)/CR	228	92	115 to 354
CT(4R-B)/SB	107	84	4 to 222
CT(6R-B)/SB	121	84	19 to 236
CT(6R-M)/SB	129	84	26 to 244
CR/SB	97	69	13 to 188

1/ Mean commodity prices: cotton - $0.70/lb., corn - $5.00/bu., soybeans - $10.00/bu.
 Mean crop yields: cotton – 1,380 lbs./acre, corn – 176 bu./acre, soybeans – 44 bu./acre.

Table 3.15 – Mean Net Return Values per Acre for Price Scenario 3 – Yield Level B 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	($/acre)	($/acre)
CT(4R-B)/CR	275	94	158 to 402
CT(6R-B)/CR	291	94	173 to 417
CT(6R-M)/CR	298	94	181 to 424
CT(4R-B)/SB	142	86	35 to 258
CT(6R-B)/SB	157	86	50 to 272
CT(6R-M)/SB	164	86	57 to 280
CR/SB	203	76	110 to 304

1/ Mean commodity prices: cotton - $0.70/lb., corn - $6.00/bu., soybeans - $12.00/bu.
 Mean crop yields: cotton – 1,380 lbs./acre, corn – 176 bu./acre, soybeans – 44 bu./acre.

Table 3.16 – Mean Net Return Values per Acre for Price Scenario 4 – Yield Level B 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	*($/acre)*	*($/acre)*
CT(4R-B)/CR	191	95	73 to 320
CT(6R-B)/CR	206	95	89 to 336
CT(6R-M)/CR	214	95	96 to 343
CT(4R-B)/SB	128	87	21 to 245
CT(6R-B)/SB	143	87	35 to 260
CT(6R-M)/SB	150	87	43 to 268
CR/SB	-8	62	-82 to 75

1/ Mean commodity prices: cotton - $0.80/lb., corn - $4.00/bu., soybeans - $8.00/bu.
   Mean crop yields: cotton – 1,380 lbs./acre, corn – 176 bu./acre, soybeans – 44 bu./acre.

Table 3.17 – Mean Net Return Values per Acre for Price Scenario 5 – Yield Level B 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	*($/acre)*	*($/acre)*
CT(4R-B)/CR	261	97	141 to 393
CT(6R-B)/CR	276	97	156 to 408
CT(6R-M)/CR	284	97	164 to 415
CT(4R-B)/SB	163	89	53 to 281
CT(6R-B)/SB	178	89	68 to 296
CT(6R-M)/SB	185	89	75 to 303
CR/SB	97	69	13 to 188

1/ Mean commodity prices: cotton - $0.80/lb., corn - $5.00/bu., soybeans - $10.00/bu.
   Mean crop yields: cotton – 1,380 lbs./acre, corn – 176 bu./acre, soybeans – 44 bu./acre.

Table 3.18 – Mean Net Return Values per Acre for Price Scenario 6 – Yield Level B 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	*($/acre)*	*($/acre)*
CT(4R-B)/CR	332	98	209 to 464
CT(6R-B)/CR	347	98	224 to 480
CT(6R-M)/CR	354	98	232 to 486
CT(4R-B)/SB	197	86	88 to 312
CT(6R-B)/SB	212	86	104 to 327
CT(6R-M)/SB	220	86	111 to 334
CR/SB	203	65	110 to 304

1/ Mean commodity prices: cotton - $0.80/lb., corn - $6.00/bu., soybeans - $12.00/bu.
   Mean crop yields: cotton – 1,380 lbs./acre, corn – 176 bu./acre, soybeans – 44 bu./acre.

Table 3.19 – Mean Net Return Values per Acre for Price Scenario 7 – Yield Level B 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	($/acre)	($/acre)
CT(4R-B)/CR	247	100	123 to 381
CT(6R-B)/CR	262	100	139 to 396
CT(6R-M)/CR	270	100	147 to 404
CT(4R-B)/SB	184	92	69 to 305
CT(6R-B)/SB	199	92	84 to 321
CT(6R-M)/SB	206	92	92 to 328
CR/SB	-8	62	-82 to 75

1/ Mean commodity prices: cotton - $0.90/lb., corn - $4.00/bu., soybeans - $8.00/bu.
   Mean crop yields: cotton – 1,380 lbs./acre, corn – 176 bu./acre, soybeans – 44 bu./acre.

Table 3.20 – Mean Net Return Values per Acre for Price Scenario 8 – Yield Level B 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	($/acre)	($/acre)
CT(4R-B)/CR	318	101	191 to 454
CT(6R-B)/CR	333	101	206 to 469
CT(6R-M)/CR	340	101	213 to 476
CT(4R-B)/SB	219	94	102 to 342
CT(6R-B)/SB	234	94	117 to 357
CT(6R-M)/SB	242	94	124 to 364
CR/SB	97	69	13 to 188

1/ Mean commodity prices: cotton - $0.90/lb., corn - $5.00/bu., soybeans - $10.00/bu.
   Mean crop yields: cotton – 1,380 lbs./acre, corn – 176 bu./acre, soybeans – 44 bu./acre.

Table 3.21 – Mean Net Return Values per Acre for Price Scenario 9 – Yield Level B 1/

Crop Rotation	Mean Net Return	Std. Dev.	80% Confidence Range
	($/acre)	($/acre)	($/acre)
CT(4R-B)/CR	388	103	258 to 527
CT(6R-B)/CR	403	103	273 to 541
CT(6R-M)/CR	410	103	280 to 549
CT(4R-B)/SB	254	96	134 to 378
CT(6R-B)/SB	269	96	149 to 392
CT(6R-M)/SB	277	96	156 to 399
CR/SB	203	76	110 to 304

1/ Mean commodity prices: cotton - $0.90/lb., corn - $6.00/bu., soybeans - $12.00/bu.
   Mean crop yields: cotton – 1,380 lbs./acre, corn – 176 bu./acre, soybeans – 44 bu./acre.

CHAPTER 4. EVALUATION OF STOCHASTIC EFFICIENCY OF CROP ROTATION NET RETURNS FOR ALTERNATIVE COTTON HARVEST SYSTEM COSTS

In the previous chapter, the impact of changing the cotton harvest system from traditional basket pickers to new onboard module pickers was evaluated by estimating mean net returns above variable costs for alternative two-year crop rotations involving cotton, corn and soybeans under random commodity market prices and crop yields for specified mean price and yield levels. Onboard module building cotton harvest systems were estimated to improve net returns from crop rotations involving cotton as a result of the lower variable harvest cost associated with the newer type cotton harvest systems.

Although this type of simulation analysis is useful in conducting a comparative analysis of cotton harvest system impacts on crop rotation net returns, it ignores the influence of risk preferences by the decision maker. Evaluation of decisions for decision makers with varying risk preferences requires relating the probabilities of potential outcomes to the utility derived from those outcomes by the decision maker. According to the subjective utility hypothesis (Anderson, et al., 1977, pp. 66-69), information about the decision maker's utility function is needed to evaluate risky alternative production choices since the shape of the utility function reflects the individual decision maker's attitude toward risk. The subjective utility hypothesis basically states that the utility derived from the choice of a particular risky production alternative is equal to the decision maker's expected utility for that alternative, involving the average of the utilities of alternative outcomes weighted by the probabilities of occurance. Evaluating risk in a decision problem provides the additional information of how decision makers' choices change over a range of risk preferences based on the utility derived from those decision choices.

4.1 Evaluation of Risk Decision Alternatives

      Basic to the analysis of risky decision choice is the concept of risk aversion and estimation of risk aversion coefficients. A decision maker's preferences toward risk can be classified into one of three categories: (a.) *risk averse* – preferring a certain income to a risky income with the same expected value, (b.) *risk neutral* – being indifferent between a certain income and an uncertain income with the same expected value, and (c.) *risk loving* – preferring a risky income to a certain income with the same expeted value (Pindyck and Rubinfeld, 2001, p. 157). The degree of risk aversion can be quantified into an absolute risk aversion coefficient defined as

$$r_a(w) = -U_2(w)/U_1(w) \tag{4.1}$$

where r_a is the absolute risk aversion parameter, w is wealth or income, and U_2 and U_1 are the second and first derivatives of the utility function (Anderson, et al., 1997, p. 90). This risk aversion coefficient is a measure of the curvature of the utility function, which is influenced by risk preferences. The coefficient is positive for risk aversion, zero for risk neutrality, and negative for risk preferring.

      Stochastic dominance has long been used as a methodology for evaluating risky decision alternatives. This methodology estimates distibutions of net returns (or outcomes) for each decision alternative, utilizing simulated values of key parameters such as commodity market prices, crop yields, and key input prices. However, a major limitation of conventional stochastic dominance analysis is that this methodology is limited to making pairwise comparsions of outcome distributions of alternatives. This type of analysis could prove cumbersome with a decision set of several risky choice alternatives.

      Stochastic dominance with respect to a function (SDRF) was introduced by Meyer (1977). Although still performing pairwise comparisons of risky choices, this procedure allowed for

tighter bounds on the specification of the range of relevant risk aversion coefficients for a decision maker considering a specific risky decision choice. Rather than assuming the range of absolute risk aversion coefficients for a risk averse decision maker was $0 < r_a(w) < +\infty$, as is the case with standard stochastic dominance analysis, the SDRF procedure allowed for the specification of a narrower range of relevant risk aversion coefficients, specifically $r_L(w) \leq r_a(w) \leq r_U(w)$, where $r_L(w)$ and $r_U(w)$ are the specified lower and upper values of the relevant risk aversion coefficient. However, in actual practice the SDRF procedure has proved challenging to use, as it often times results in ambiguous rankings that suggest that rankings change between the upper and lower bound on the risk aversion coefficient (Schumann, et al., 2004).

4.2 SERF Analysis

Stochastic efficiency with respect to a function (SERF), developed by Hardaker, et al., (2004) has been proposed as a more transparent and potentially more discriminating SDRF method. The SERF method identifies utility efficient risky decision alternatives for ranges of risk attitudes, rather than identifying a subset of dominated alternatives. SERF orders risky alternatives in terms of their certainty equivalents (CE) as a selected measure of risk aversion varied over a specified range.

The certainty equivalent (CE) of a risky decision alternative is the specific certain sum of money which would have the same utility to the decision maker as the expected utility of the risky decision alternative. For a rational decision maker who is risk averse, the estimated CE is typically less than the expected monetary value (EMV) of the risk alternative and is also greater than or equal to the minimum possible value. The difference between the CE and the EMV is called the *risk premium* of that risky alternative and is a measure of how much the decision maker

would need to be paid (i.e., receive) to be indifferent between choosing the risky alternative or taking the certainty equivalent.

Following Hardaker, et al., the certainty equivalent of a risky decision alternative can be stated mathematically as

$$CE\ (w,\ r_a(w)) = U^{-1}(w, r_a(w))\tag{4.2}$$

where CE is the certainty equivalent, w is wealth or income from the risky alternative, $r_a(w)$ is the risk aversion parameter, U^{-1} is the inverse of the utility function and w is a measure of wealth for a specific risky alternative. The specific determination of the CE function depends on the type of utility function assumed. Using the common negative exponential utility function which implies a constant aversion to risk, $(U(w) = -exp(-r_a w))$, the estimated certainty equivalent function would be defined as

$$CE(w, r_a(w)) = ln\left\{\left(\frac{1}{n}\sum_i^n \exp(-r_a(w)w_i)\right)^{-1/r_a(w)}\right\}\tag{4.3}$$

This specification of the certainly equivalent allows for the inclusion of the expected monetary value (EMV) of risky decision alternatives for $r_a(w) = 0$ (risk neutrality).

By using the risk analysis methodology as specified in SERF, a vector of certainty equivalent values can be estimated for each risky decision alternative for a range of risk aversion coefficients. A risk efficient set of decision choices can then be defined as those alternatives which have the highest certainty equivalent values, thereby dominating other alternatives with lower certainty equivalent values.

In the analysis presented here, wealth *(w)* is defined as the average net return above variable cost per year (on per acre basis) for a two-year crop rotation sequence. Net returns (wealth) for specified alternative two-year crop rotations were estimated using the following net return equation:

$$w_T = NR_T = [NR_{i,1,j} + NR_{j,2,i}] / 2 \tag{4.4}$$

where NR_T represents the average net return above variable cost per acre per year for a two-year crop rotation sequence *T*, $NR_{i,1,j}$ represents the expected net return above variable cost per acre of crop *i* planted in year 1 in rotation with crop *j*, and $NR_{j,2,i}$ represents the expected net return per acre of crop *j* planted in year 2 in rotation with crop *i*. Stochastic net returns for each crop rotation under alternative mean levels of crop yields and market prices were simulated using a procedure developed by Richardson, et al. (2000) and available in the software package *Simetar* (Richardson, et al., 2008). Calculation of the certainty equivalents and comparison over alternative risky crop rotation sequence alternatives were conducted using the Excel based SERF approach developed by Hardaker, et al. (2004).

An issue arises within this type of risk analysis regarding the appropriate values and range of absolute risk aversion coefficients to evaluate for a given risky decision choice. One methodology to address this issue is to evaluate the relationship between absolute and relative risk aversion (Hardaker, et al., 2004). This relationship may be expressed mathematically as follows:

$$r_a(w) = r_r(w)/w \tag{4.5}$$

where r_a is the absolute risk aversion coefficient, r_r is the relative risk aversion coefficient and w is the wealth from a given risky choice. The relative risk aversion coefficient (r_r) serves the purpose of scaling the value of the absolute risk aversion coefficient to the magnitude of the measure of wealth. Anderson and Dillon (1992) have proposed a general classification range of relative risk aversion coefficients in the range of 0.0 for no risk, 0.5 for very little risk, and an upper value of approximately 4.0 for very risky choices. Absolute risk aversion coefficients to be utilized in this analysis were obtained by dividing a range of relative risk aversion coefficients (0.0 to 4.0) by an approximate average estimated net return per acre over all alternative crop rotation choices. Using this procecure, certainty equivalent values were estimated for each crop rotation sequence over alternatively specified mean levels of commodity market price and crop yield over a range of absolute risk aversion coefficients specified as 0.0 (no risk) to 0.06 (more risky) as determined in equation 4.5.

SERF analysis was conducted on the estimated crop rotation net return simulated distrbutions based on alternative mean levels of crop market prices and yields analyzed in this study as estimated in the previous chapter. Graphical presentations of SERF analysis results conducted for alternative crop price and yield scenarios, assuming crop yield level A price and yield parameters as presented in Table 3.2, are shown in Figures 4.1 – 4.9. Seven certainty equivalent plots are shown in each figure. These plots are for the two-year crop rotation sequences analyzed in this study and include: (1) CT-CR-1 (cotton/corn/4-row basket picker), (2) CT-SB-1 (cotton/soybean/4-row basket picker), (3) CT-CR-2 (cotton/corn/6-row basket picker), (4) CT-SB-2 (cotton/soybean/6-row basket picker), (5) CT-CR-3 (cotton/corn/6-row module picker), (6) CT-SB-3 (cotton/soybean/6-row module picker), and (7) CR-SB (corn/soybeans).

Graphical SERF analysis results for selected crop price and yield scenarios, assuming crop yield level B price and yield parameters as presented in Table 3.12, are shown in Figures 4.10 – 4.18.

Figure 4.1 presents a graph of the SERF results for price scenario 1 and yield level A. Mean commodity market price levels in this graph are $0.70 per pound for cotton lint, $4.00 per bushel for corn and $8.00 per bushel for soybeans. Mean rotational crop yield levels simulated were 1,150 pounds of cotton lint per acre, 154 bushels of corn per acre and 44 bushels of soybeans per acre. Use of the cotton module building harvest system increased average two-year crop rotation net returns above variable costs by $7.00 per acre per year over the 6-row basket cotton harvest system and by $22.00 per acre per year over the 4-row basket cotton harvest system for both cotton rotations involving corn and soybeans. The net return differences correlate with values presented in Table 3.3.

In general, the cotton/corn rotations were found to be more risk efficient than the cotton/soybean rotations due to the differences in mean net return values at these commodity price levels. Compared to the plot of the certainty equivanlents for the corn/soybean rotation (CR-SB), the decrease in certainty equivalents are much greater for the rotations involving cotton over the range of absolute risk aversion coefficients evaluated due to the increased variability of net returns associated with cotton. For risk neutral decision makers (absolute risk aversion coefficient = 0), cotton/corn rotations are more risk efficient and preferred over cotton/soybean and corn/soybean rotations (Figure 4.1). However, as the degree of risk averseness on the part of the decision maker increases, the superiority of cotton/corn rotations quickly decreases, until eventually the corn/soybean rotation becomes the most preferred rotation for very risk averse decision makers. The cost advantages of the module building cotton harvest system resulted in the greater values of

net return certainty equivalents compared with alternative cotton harvest systems for both the cotton/corn rotations and the cotton/soybean rotations.

As evidenced by an examination of the certainty equivalent graphs depicted in Figures 4.1 through 4.18, the preference for one crop rotation over an alternative rotation at various risk preference levels is highly dependent on the assumed mean level of crop market prices and yields. A couple of comparisons will be discussed here for illustrative purposes.

If cotton market prices remain relatively low, it is difficult for cotton to compete economically in the two-crop rotation system with corn and soybeans for risk averse producers. With low cotton market prices and mid-level grain prices (Figure 4.2), a corn/soybean rotation begins to dominate a cotton/soybean rotation at an absolute risk aversion coefficient value of 0.01. The corn/soybean rotation dominates the cotton/corn rotation beginning at an absolute risk aversion coefficient value of 0.04. At higher grain market prices which have been recently observed over the past few years (Figure 4.3), the corn/soybean rotation completely dominates the cotton/soybean rotations at all absolute risk aversion coefficient levels and also dominates the cotton/corn rotations beginning at a value of 0.0225.

Higher sustained levels of cotton market prices provide much greater ability for cotton to compete for acreage within crop rotation systems. Examimation of Figures 4.4 through 4.9 illustrate the impact of mean cotton market price levels of $0.80 and $0.90 per pound on the estimated certainty equivalents of net returns from two-year rotations including cotton as a crop choice. Although the use of an onboard module building cotton harvest system does increase the expected net return/certainty equivalent of cotton rotations utilizing this type of harvest system over alternative cotton harvest systems, the expected mean market price level for cotton has a much greater impact on crop rotation net returns.

Over the past couple of years, corn yields in Louisiana have increased significantly. In addition, with the reduction in cotton acreage in the state, the yield of cotton on acres remaining in cotton production has also increased. To evaluate this situation, a second set of SERF analyses were conducted utilizing higher levels of cotton and corn yields. The graphs of the SERF analysis for each of the price and yield combinations evaluated in this portion of the study are shown in Figures 4.10 through 4.18. Here, the three mean levels of crop prices evaluated remain the same, as does the mean soybean yields of 40 bushels per acre on monocrop production and 44 bushels per acre in rotation with another crop. Mean cotton yields were increased to 1,200 pounds per acre in monocrop production and 1,380 pounds per acre (+15%) in rotation with corn or soybeans. Mean corn yields were increased to 160 bushels per acre in monocrop production and 176 bushels per acre (+10%) in rotation with cotton or soybeans.

Evaluation of the plots of the certainty equivalents of net returns for alternative two-year crop rotation systems under this yield scenario yield results similar to previously presented. In general, the cotton/corn rotation dominates both the cotton/soybean and corn/soybean rotations. At low mean crop market price levels (Figure 4.10), the cotton/corn rotation dominates both the cotton/soybean and corn/soybean rotations over the range of absolute risk aversion coefficient values considered (0.00 to 0.06). With a mean cotton price of $0.70 per pound, higher levels of mean grain prices result in the corn/soybean rotation becoming more dominant over cotton/soybean rotations (Figures 4.11 and 4.12). As the risk averseness of the producer increases, the estimated the dominance of the cotton/corn rotations over corn/soybean rotations remains, although the difference between estimated certainty equivalent values narrows considerably. Although use of onboard module harvesters does increase the economic competitiveness of cotton within rotations, the general level of expected market price and yields also has a big impact.

Mean crop prices/yields: cotton - $0.70/lb. & 1,150 lbs./acre; corn - $4.00/bu. & 154 bu./acre; soybeans - $8.00/bu. & 44 bu./acre.
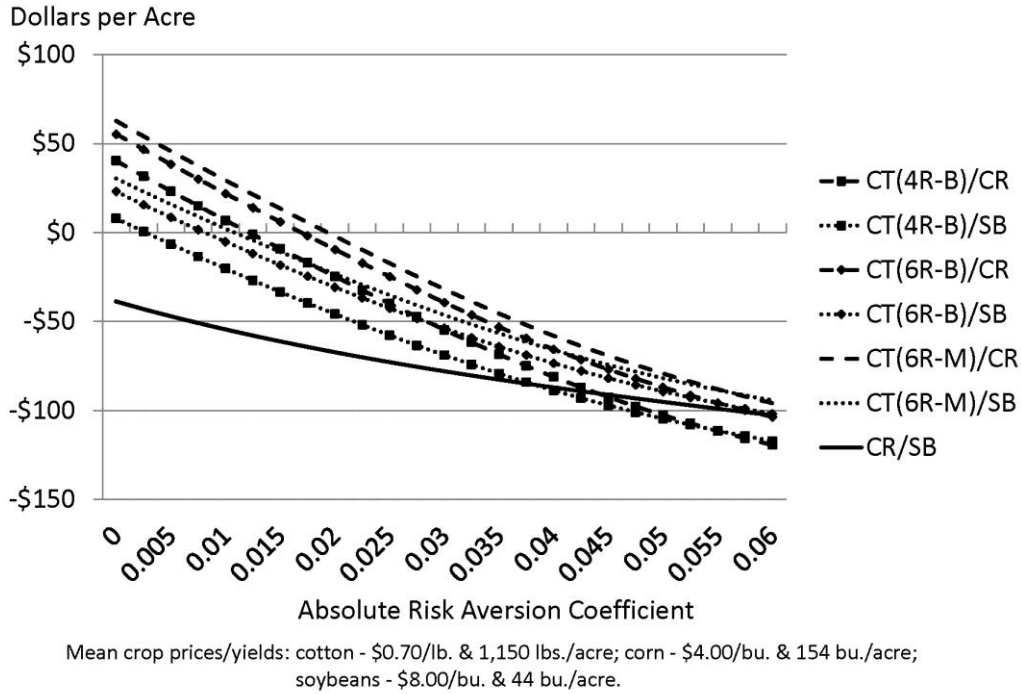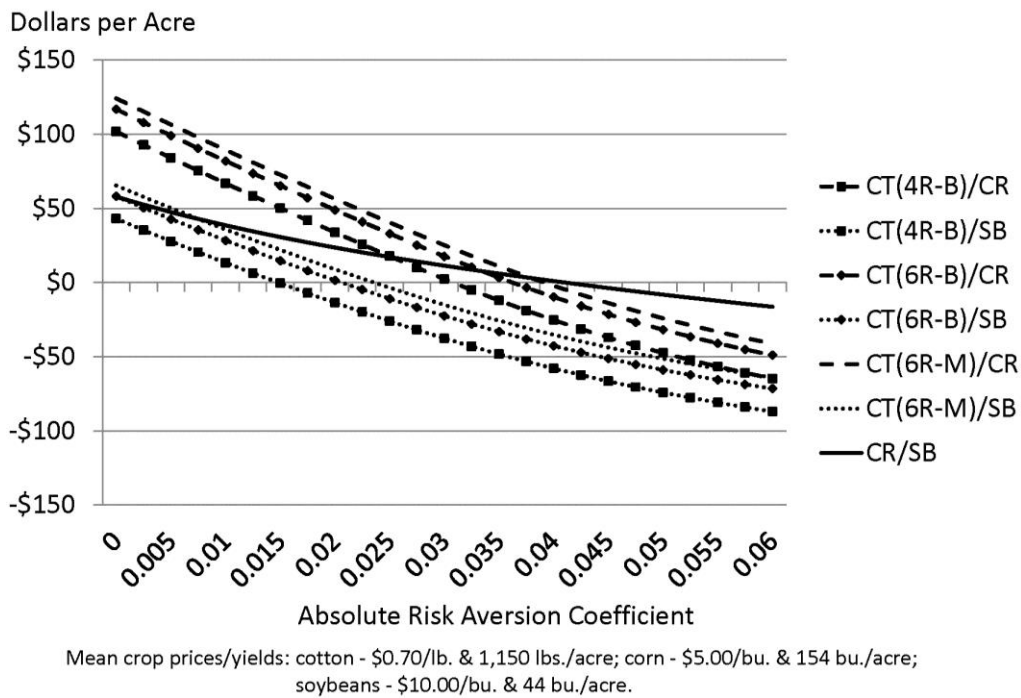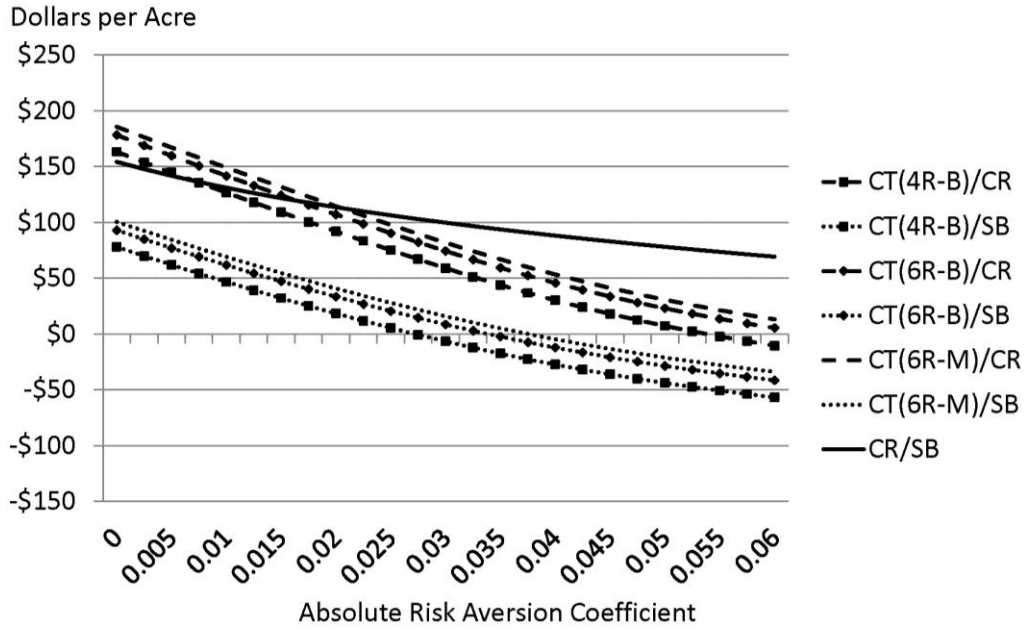
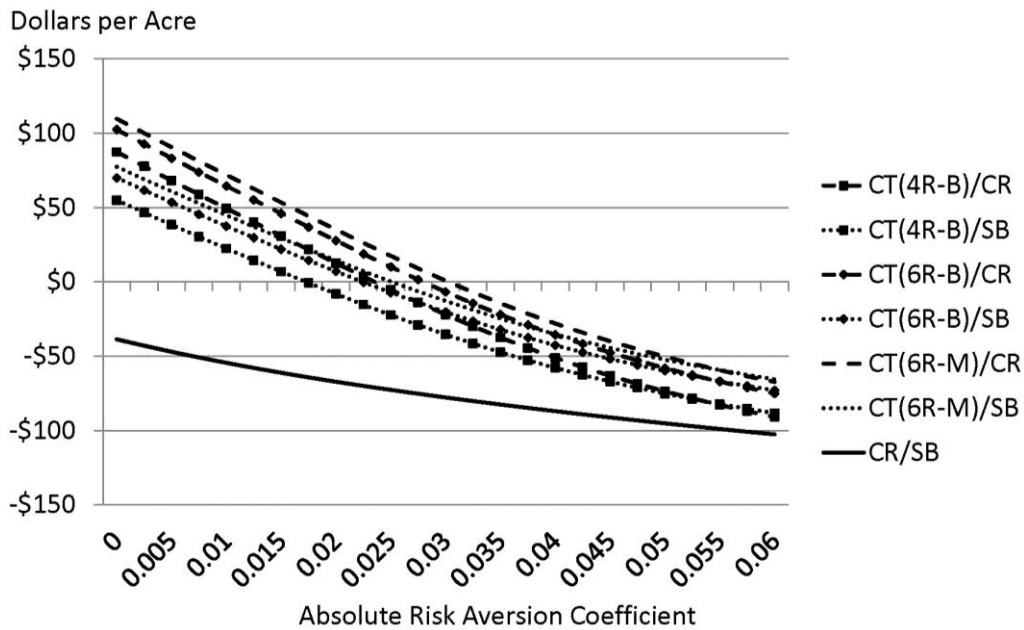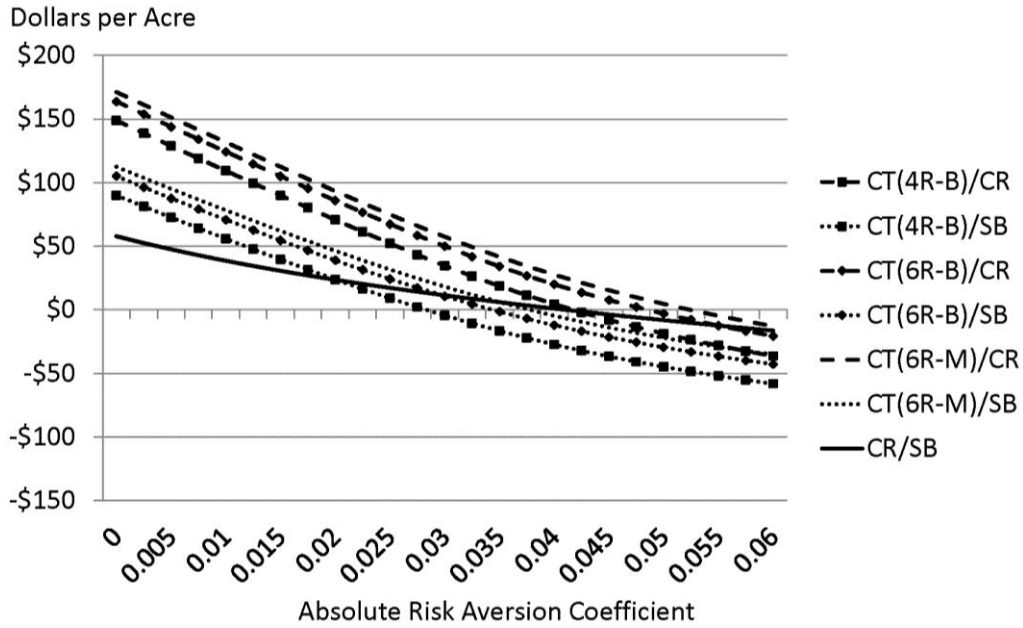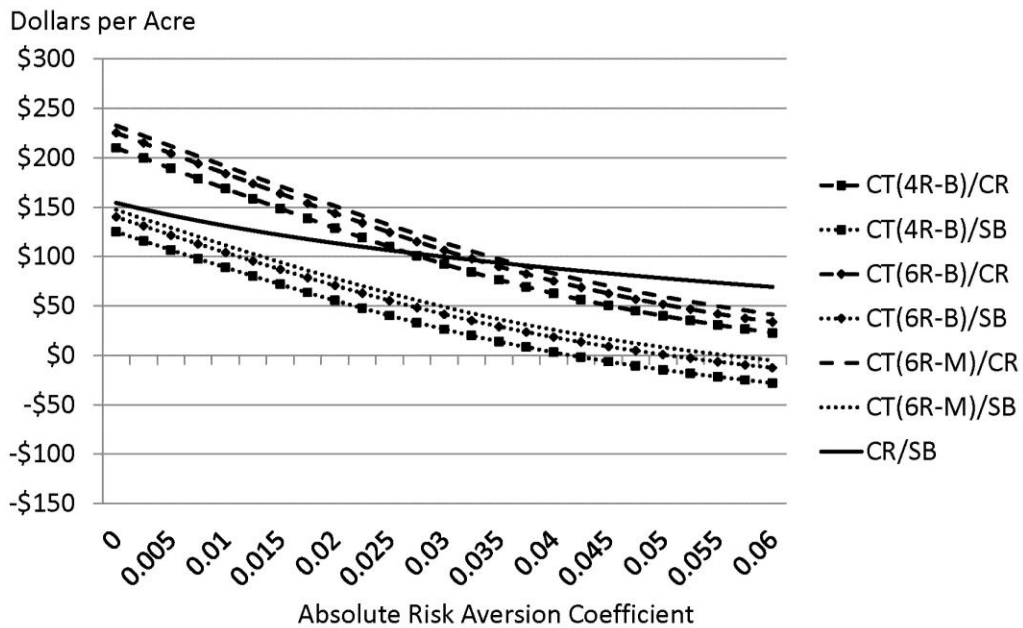Figure 4.1 – SERF Analysis Results, Price Scenario 1, Yield Level A

Mean crop prices/yields: cotton - $0.70/lb. & 1,150 lbs./acre; corn - $5.00/bu. & 154 bu./acre; soybeans - $10.00/bu. & 44 bu./acre.

Figure 4.2 – SERF Analysis Results, Price Scenario 2, Yield Level A

Mean crop prices/yields: cotton - $0.70/lb. & 1,150 lbs./acre; corn - $6.00/bu. & 154 bu./acre; soybeans - $12.00/bu. & 44 bu./acre.

Figure 4.3 – SERF Analysis Results, Price Scenario 3, Yield Level A

Mean crop prices/yields: cotton - $0.80/lb. & 1,150 lbs./acre; corn - $4.00/bu. & 154 bu./acre; soybeans - $8.00/bu. & 44 bu./acre.
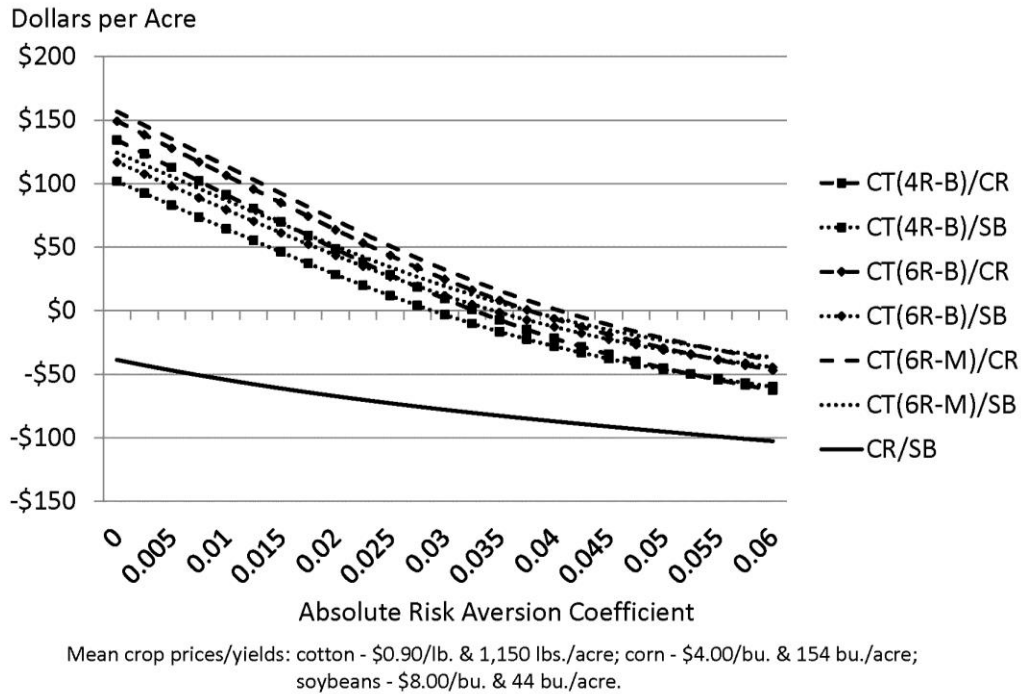
Figure 4.4 – SERF Analysis Results, Price Scenario 4, Yield Level A

Dollars per Acre

Mean crop prices/yields: cotton - $0.80/lb. & 1,150 lbs./acre; corn - $5.00/bu. & 154 bu./acre; soybeans - $10.00/bu. & 44 bu./acre.

Figure 4.5 – SERF Analysis Results, Price Scenario 5, Yield Level A

Dollars per Acre

Mean crop prices/yields: cotton - $0.80/lb. & 1,150 lbs./acre; corn - $6.00/bu. & 154 bu./acre; soybeans - $12.00/bu. & 44 bu./acre.
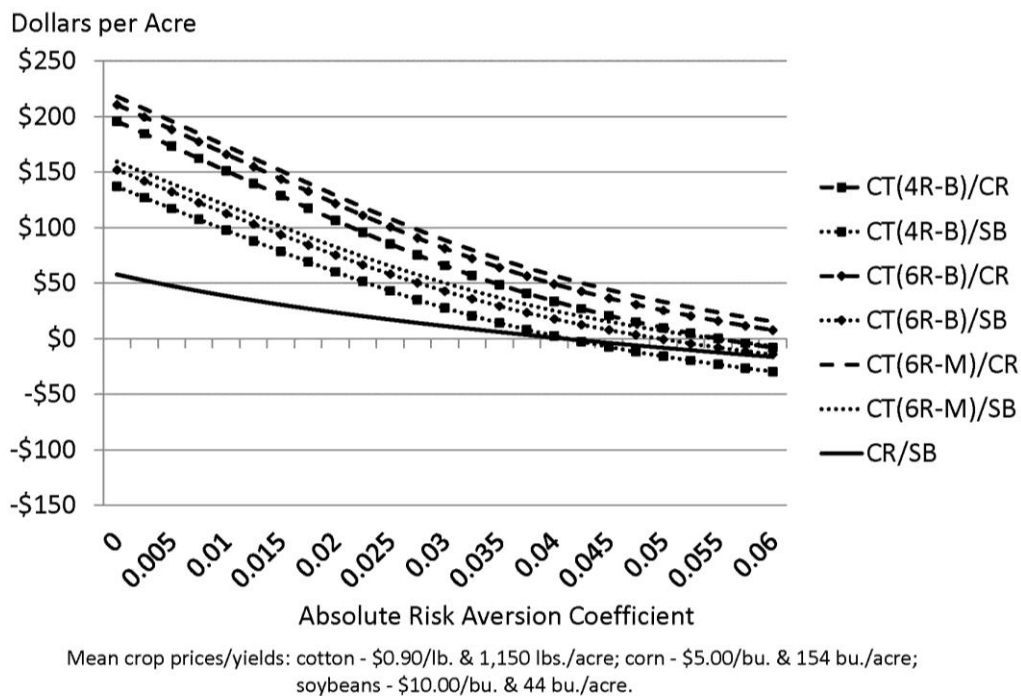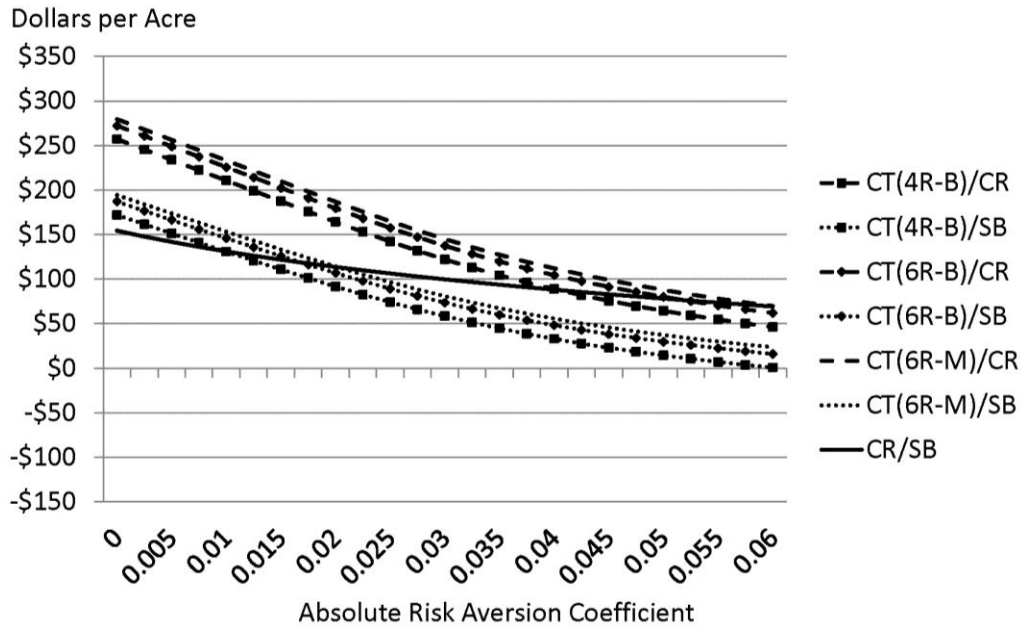
Figure 4.6 – SERF Analysis Results, Price Scenario 6, Yield Level A

Mean crop prices/yields: cotton - $0.90/lb. & 1,150 lbs./acre; corn - $4.00/bu. & 154 bu./acre; soybeans - $8.00/bu. & 44 bu./acre.

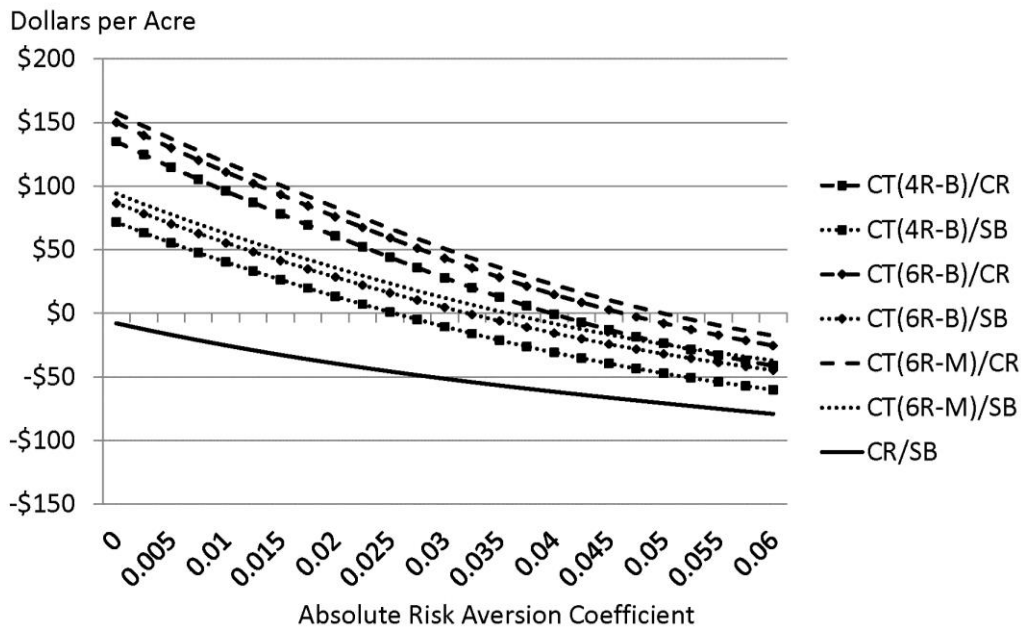Figure 4.7 – SERF Analysis Results, Price Scenario 7, Yield Level A

Mean crop prices/yields: cotton - $0.90/lb. & 1,150 lbs./acre; corn - $5.00/bu. & 154 bu./acre; soybeans - $10.00/bu. & 44 bu./acre.

Figure 4.8 – SERF Analysis Results, Price Scenario 8, Yield Level A

Mean crop prices/yields: cotton - $0.90/lb. & 1,150 lbs./acre; corn - $6.00/bu. & 154 bu./acre; soybeans - $12.00/bu. & 44 bu./acre.

Figure 4.9 – SERF Analysis Results, Price Scenario 9, Yield Level A

Mean crop prices/yields: cotton - $0.70/lb. & 1,380 lbs./acre; corn - $4.00/bu. & 176 bu./acre; soybeans - $8.00/bu. & 44 bu./acre.

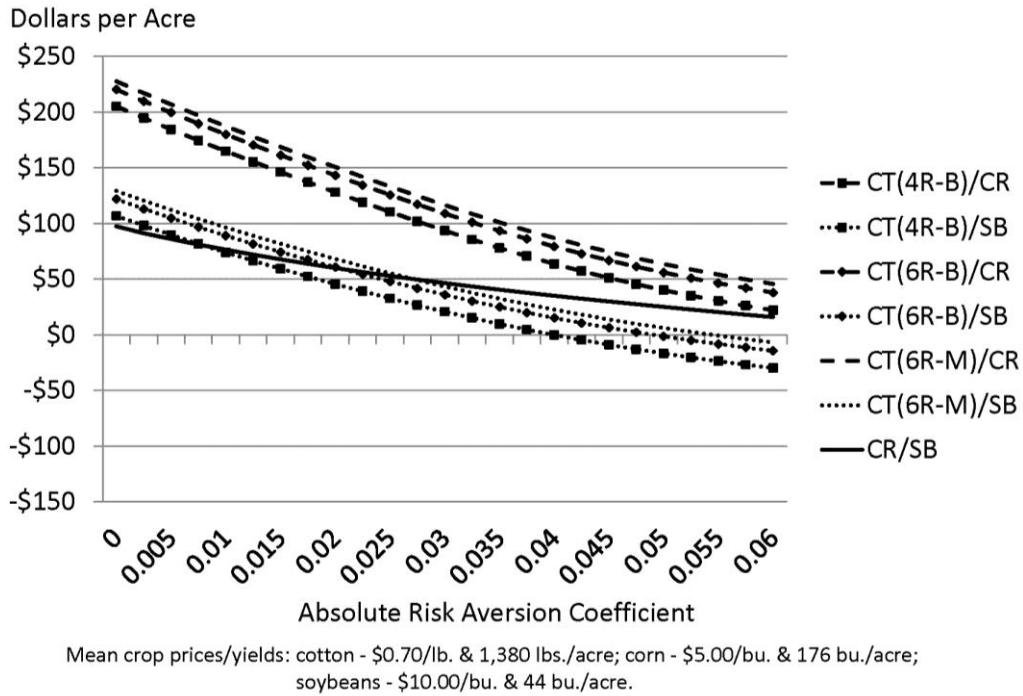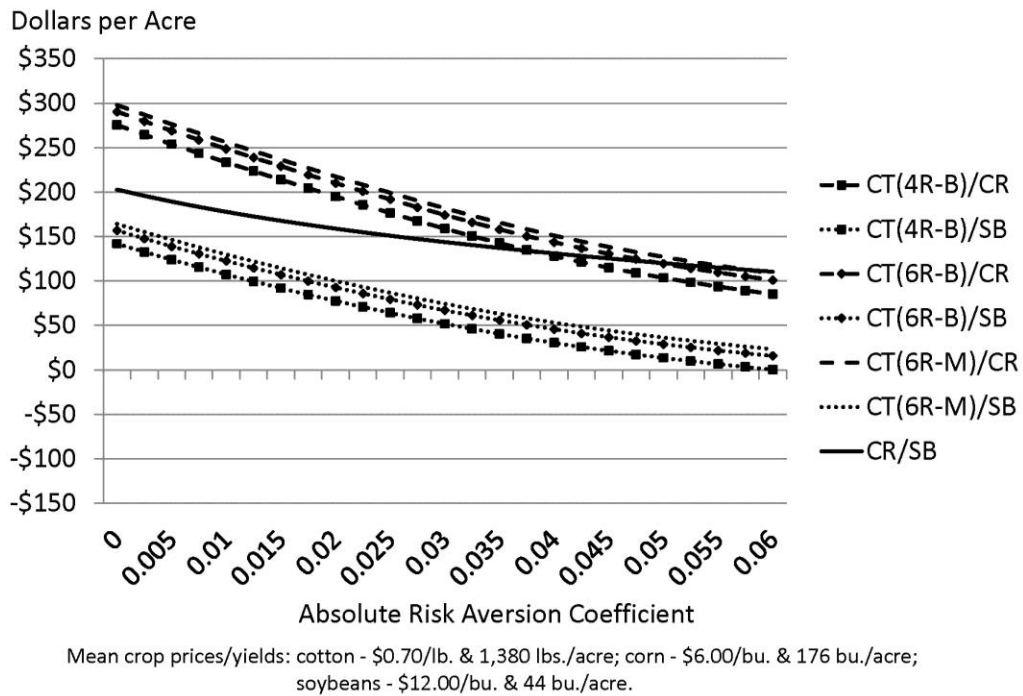Figure 4.10 – SERF Analysis Results, Price Scenario 1, Yield Level B

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Mean crop prices/yields: cotton - $0.70/lb. & 1,380 lbs./acre; corn - $5.00/bu. & 176 bu./acre; soybeans - $10.00/bu. & 44 bu./acre.

Figure 4.11 – SERF Analysis Results, Price Scenario 2, Yield Level B

Mean crop prices/yields: cotton - $0.70/lb. & 1,380 lbs./acre; corn - $6.00/bu. & 176 bu./acre; soybeans - $12.00/bu. & 44 bu./acre.
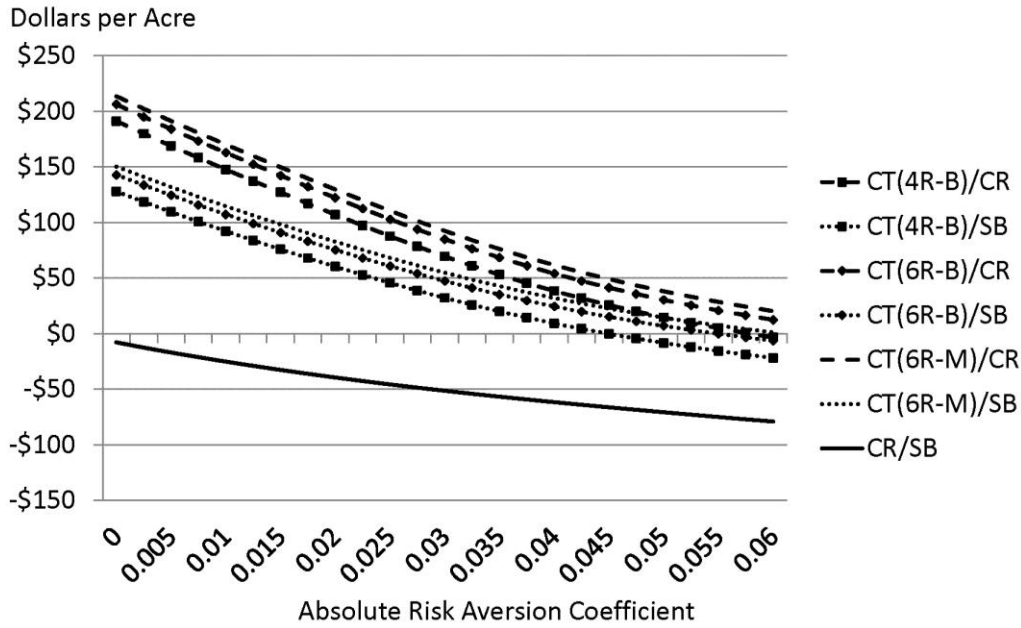
Figure 4.12 – SERF Analysis Results, Price Scenario 3, Yield Level B

Mean crop prices/yields: cotton - $0.80/lb. & 1,380 lbs./acre; corn - $4.00/bu. & 176 bu./acre; soybeans - $8.00/bu. & 44 bu./acre.
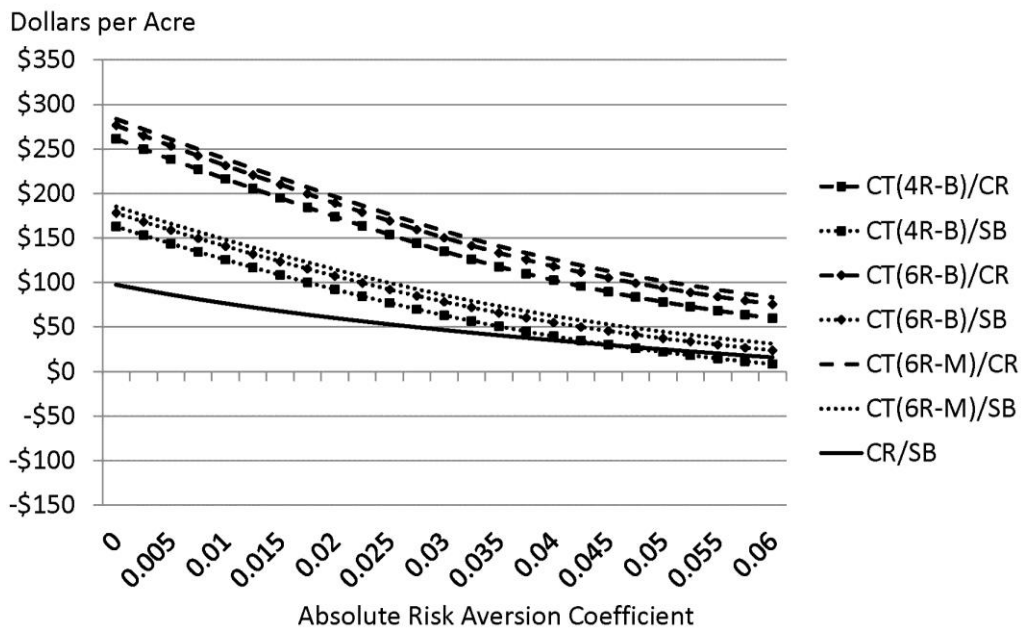
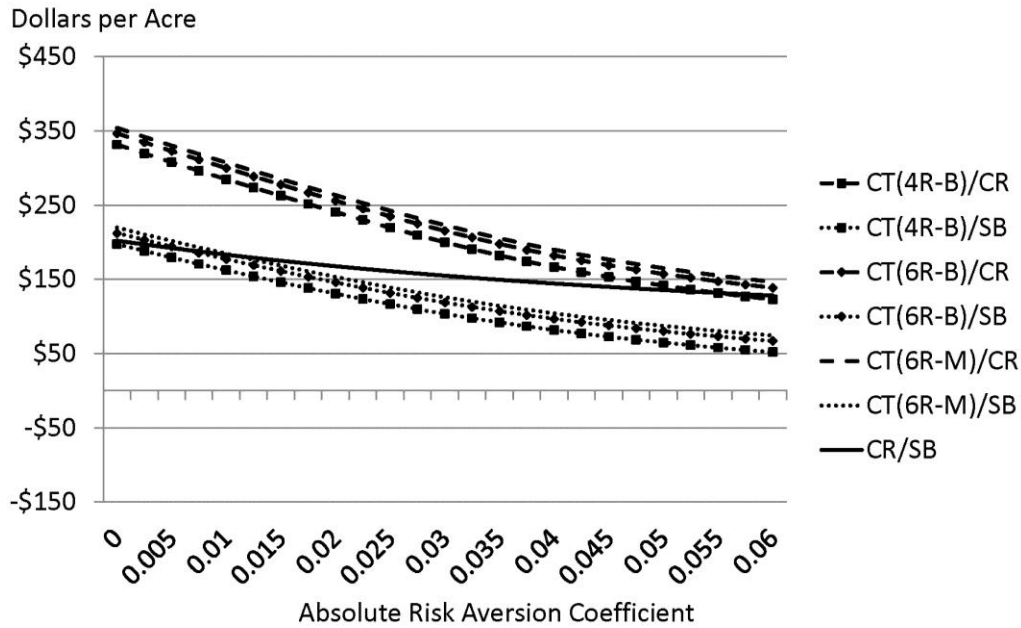Figure 4.13 – SERF Analysis Results, Price Scenario 4, Yield Level B

Mean crop prices/yields: cotton - $0.80/lb. & 1,380 lbs./acre; corn - $5.00/bu. & 176 bu./acre; soybeans - $10.00/bu. & 44 bu./acre.

Figure 4.14 – SERF Analysis Results, Price Scenario 5, Yield Level B

Mean crop prices/yields: cotton - $0.80/lb. & 1,380 lbs./acre; corn - $6.00/bu. & 176 bu./acre; soybeans - $12.00/bu. & 44 bu./acre.

Figure 4.15 – SERF Analysis Results, Price Scenario 6, Yield Level B

Mean crop prices/yields: cotton - $0.90/lb. & 1,380 lbs./acre; corn - $4.00/bu. & 176 bu./acre; soybeans - $8.00/bu. & 44 bu./acre.

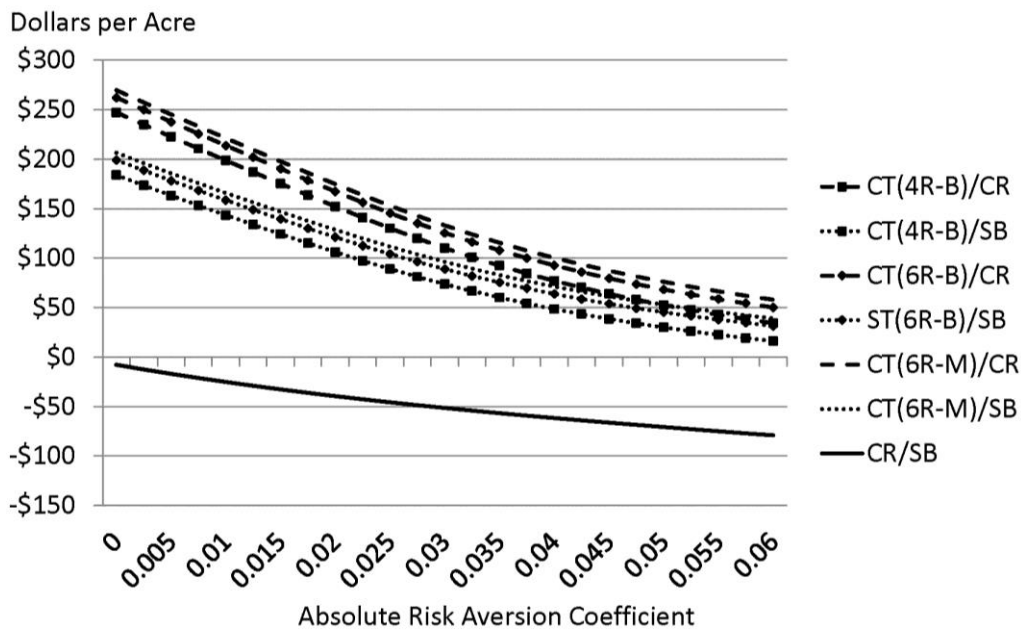Figure 4.16 – SERF Analysis Results, Price Scenario 7, Yield Level B

Dollars per Acre

Mean crop prices/yields: cotton - $0.90/lb. & 1,380 lbs./acre; corn - $5.00/bu. & 176 bu./acre; soybeans - $10.00/bu. & 44 bu./acre.

Figure 4.17 – SERF Analysis Results, Price Scenario 8, Yield Level B

Dollars per Acre

Mean crop prices/yields: cotton - $0.90/lb. & 1,380 lbs./acre; corn - $6.00/bu. & 176 bu./acre; soybeans - $12.00/bu. & 44 bu./acre.

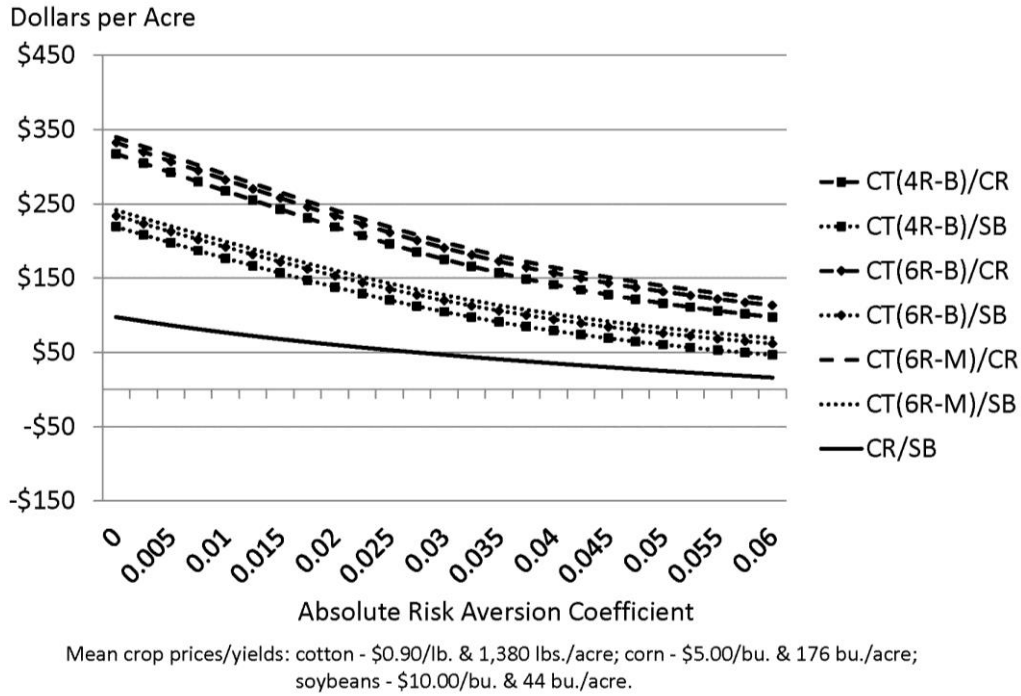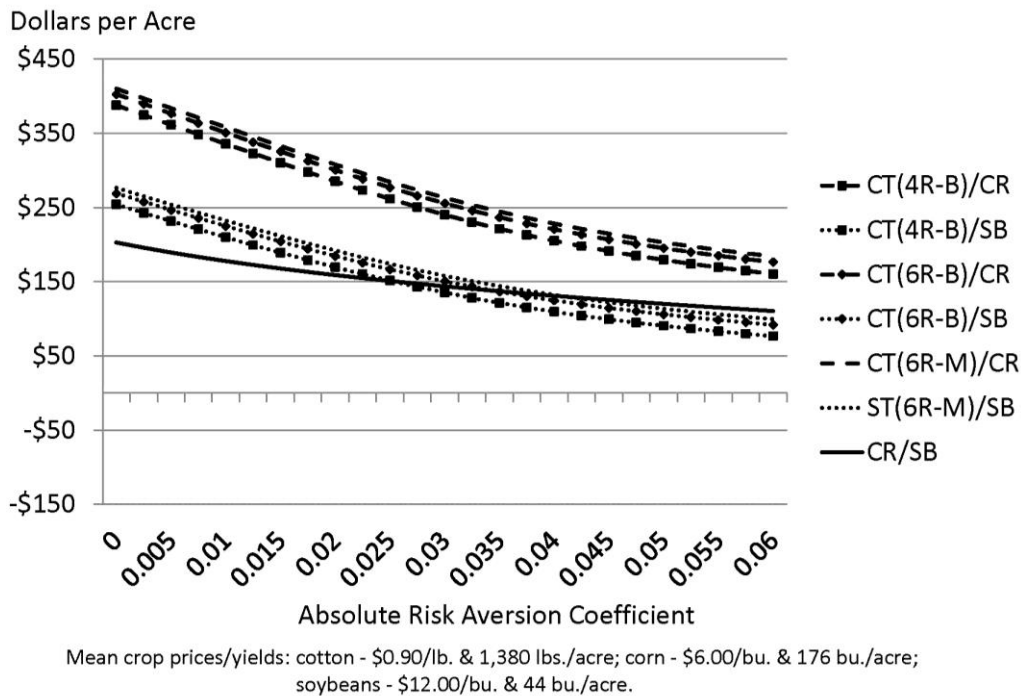Figure 4.18 – SERF Analysis Results, Price Scenario 9, Yield Level B

CHAPTER 5. SUMMARY AND CONCLUSIONS

Planted acreage of cotton in Louisiana has decreased substantially over the past several years due to a combination of factors including higher cotton variable production costs, stagnant cotton market prices, and higher grain yields and market prices for corn and soybeans. In recent years, the cotton acreage that was planted in the state has generally been by those producers who have some stake in a cotton gin, whereby they would be receiving returns from the gin operation to supplement returns from cotton production. The development of new onboard module building cotton harvest systems offer cotton producers the opportunity to lower cotton harvest costs and thereby increase the economic competitiveness of cotton for planted crop acreage. The general objective of this study was to determine the economic impact of the adoption and use of these newer cotton harvest systems on the ability of the cotton enterprise to compete for planted acreage in the mixed crop farming areas of Louisiana. Specific research objectives included the estimated of comparative ownership and operating costs for the module building harvest systems relative to exising basket/module builder harvest systems, and to evaluate the impact of the use of the new cotton harvest system on expected levels of crop rotation net returns. In addition, SERF analysis was utilized to evaluate the impact of risk preferences on the crop rotation decision.

In terms of operational efficiency, the new 6-row onboard module building cotton picker has a higher estimated performance rate of 9.40 acres per hour, versus 6.77 for a 6-row basket picker and 3.89 acres per hour for a 4-row basket picker. Regarding variable operation cost of the harvest units individually, the total fuel and labor cost for the module picker was estimated to be $9.82 per acre, representing a decrease of $6.24 compared with the 4-row basket picker ($16.06 per acre), and $0.44 compared to a 6-row basket picker whose cost is $10.26 per acre. One of the

primary reasons for this lower operating cost for the onboard module harvester is related to its greater field efficiency. The ability to build and unload a wrapped module of cotton without having to stop greatly enhances the field efficiency of this newer harvest system. Six-row module building cotton pickers were estimated to have the ability to harvest 9.40 acres of cotton per hour, compared to 3.89 and 6.77 acres per hour for the 4-row and 6-row basket pickers.

Without the need for additional field equipment such as boll buggys and external module builders, the onboard module building cotton harvest system has a lower total system cost than the basket type harvest systems. The total cotton system harvest cost, on a per acre basis, for a module picker was estimated to be $51.43 per harvested acre, compared to $77.43 per acre for a 6-row basket harvest system and $149.17 per acre for a 4-row basket harvest system. Assuming an annual use of 250 hours per year, a 6-row module picker can cover approximately 2,300 acres of cotton in a harvest season, compared to about 1,700 acres for a 6-row basket picker. Being able to spread a higher fixed ownership cost over more acres in a season, resulted in estimated fixed costs per acre of $29 for the 6-row module system, compared to $40 for the 6-row basket system.

The implementation of an onboard module building cotton harvest system was estimated to have an impact on the competitiveness of cotton within a crop rotation systems, at the different price and yield scenarios considered in this analysis. Two levels of mean crop yields were evaluated in this study. One yield scenario was based on the average yield history in the region, with mean simulated crop yields, in rotaton with an alternative crop, of 1,150 pounds per acre for cotton, 154 bushels per acre for corn and 44 bushels per acre for soybeans. A second yield scenario was also evaluated to reflect the recently observed higher yields for cotton and corn. This yield scenario utilized mean simulated yields of 1,380 pounds per acre for cotton and 176 bushels per acre for corn, with soybean yields at prior levels. Combinations of three alternative mean

market price levels were simulated for each of the three crops in the various crop rotations evaluated.

Results from the analysis indicated that cotton/corn rotations generally had higher expected net returns above variable costs over cotton/soybean and corn/soybean rotations under the price, yield and cost assumptions of the study. The use of the onboard module building cotton harvest systems did show an economic advantage in terms of lower cotton harvest costs translating into higher net returns. However, results from this study seemed to suggest that the mean level of commodity market price and crop yield were still the primary factors which influenced crop selection within a rotation system with the goal of maximizing net returns above variable production costs.

Research results from the analysis of the risk efficiency evaluation of crop rotation alternatives indicated that the cotton/corn rotations were generally more dominate than the cotton/soybean rotations, due primarily to the higher level of expected net returns from corn production compared to expected net returns from soybean production. The greater degree of variation in net returns from cotton production resulted in a steeper decline in estimated values of certainty equivalents for cotton/corn and cotton/soybean rotations compared to corn/soybean rotations. Although the adoption of onboard module building harvest systems did improve the expected net returns associated with cotton production, the risk analysis along with the net return simulation analysis conducted in this study confirmed the continuing importance of the levels of expected crop market prices and yields in determining optimal crop rotation choices.

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